The Blast Furnace and Steel Plant

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The Blast Furnace and Steel Plant

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A Radical Departure

THE Merchants' Association of New York have opened the New Year with a new and apparently practical method of getting their community message over to a large clientele of public-spirited members.

The Service Bulletin method of digests in recent vogue by various publications has been inaugurated by the Association. The Bulletin appears not periodically, but only when occasion warrants.

The high spots in the plan are:

First—Everything in typewritten form is boiled down as though telegraphed, and only such material is given as is of service to the membership.

Second—The loose-leaf plan and the heading references are intended to facilitate actual use within the institution.

Third—Any lengthy subjects are included as inserts so they will not take away from the brevity of the main service and can be read or not as interest dictates.

Fourth—Such enclosures as the legislative service have a practical value in being separate, as many people wish to file them for reference.

In this era of rapid changes and revolutionary progress, this plan of education and publicity offers a daring but practical way of securing co-operative interest. Should it be adopted by other cities, such as Pittsburgh, St. Louis or Chicago, there is greater likelihood that the ambitious programs which each of those cities have mapped out for accomplishment would be more easily and expeditiously fulfilled.

Electric Furnace Progress in 1925

No Feature in Metallurgy Possesses More Interesting Possibilities Many Phases Are Covered by This Analysis

By **FRANK HODSON***

IT was the intention to make this article a comprehensive summary of all Electric furnaces and heating appliances installed in 1925, but it was found the subject was so wide that this could not be done, and I have had to content myself with briefly describing some of the more notable installations. I have endeavored, as far as possible, to mention those furnaces that appear to me to have considerable future scope, but in addition there have been installed a very large number of what might be termed "standard furnaces," which are by this time familiar to most of the readers of this publication.

There has been a certain amount of reluctance on the part of some of the furnace manufacturers and their customers to have their equipment described. This is apparently inevitable with any new type of equipment and I am all the more indebted to those companies who have so kindly placed information at my disposal. On this account it has not been possible to give figures showing the total kva. installed, but there is not the slightest doubt but that the year 1925 has shown an extremely rapid development in the use of electricity for heating and industrial purposes. I believe if the figures were available they would probably show 100 per cent increase over any previous years.

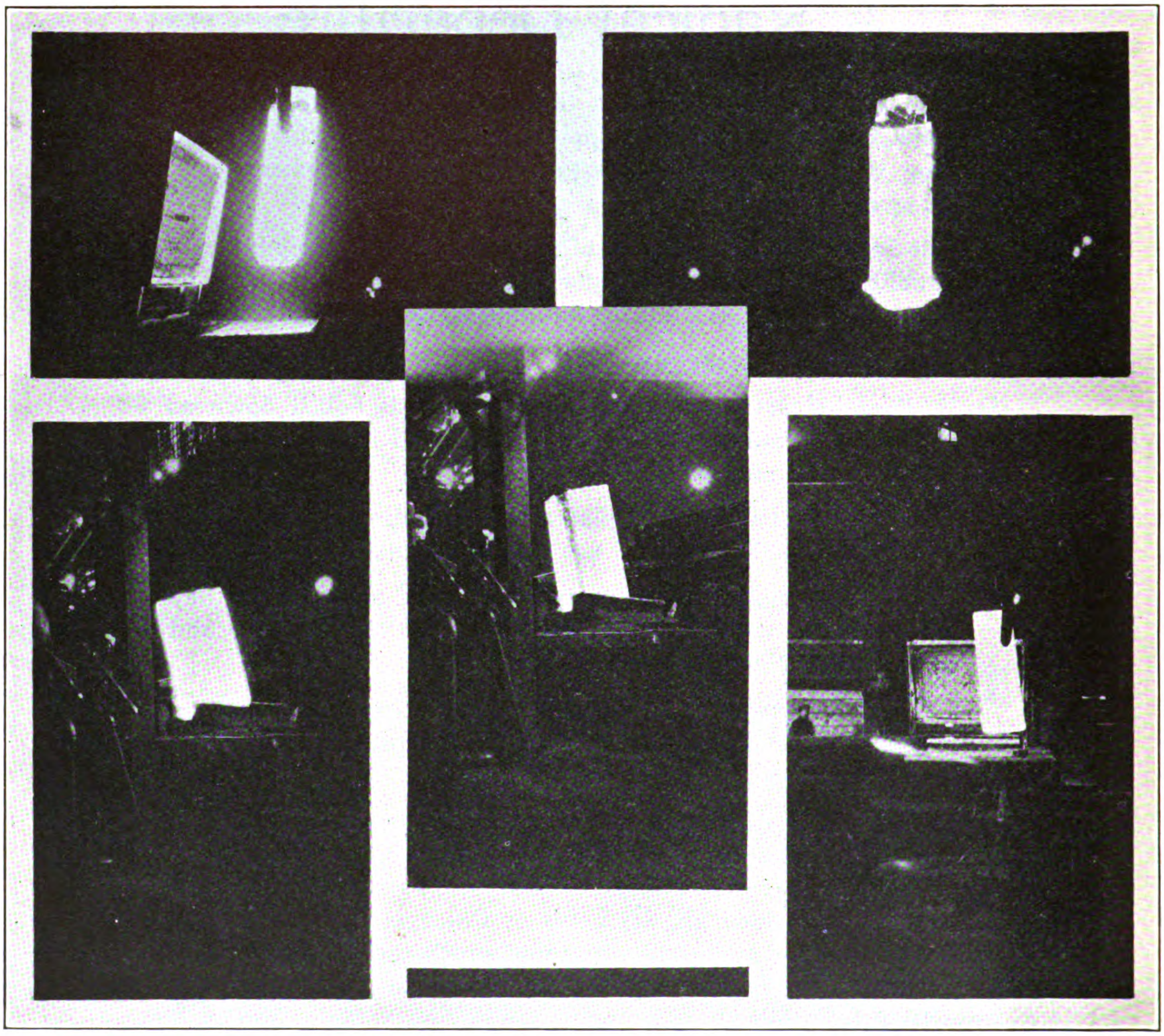

FIG. 1—*Several views of an ingot heated in an electrically heated soaking pit at Donner Steel. Note the brilliancy of the white color.*

---

*Consulting Engineer, Jefferson Building, Philadelphia, Pa.

The Use of Electricity in Soaking Pits.

There are a number of highly important new installations that will have to be passed over briefly, but I have endeavored to show where information concerning these furnaces can be obtained, so that anyone particularly interested will be able to follow the development and keep in touch with what has been done. In the last category comes the use of electricity in soaking pits for steel or other metallic ingots. Probably the most notable installation of this character is that made at the Donner Steel Company, Buffalo. It was fully described in a paper presented by Mr. R. A. Butler, Efficiency Engineer of the Donner Steel Company to the Iron and Steel Electrical Engineers, (September 1925, issue of the Iron and Steel Engineer), and described by the inventor Mr. T. F. Baily in (The Blast Furnace and Steel Plant, March 1925.) This furnace is of the resistance type using carbon as a resistor. Mr. Butler reports that:

> "The electrically heated ingot broke down ideally in rolling. They went through the rolls straight and showed no signs of twisting or bending. In addition they gave evidences of rolling easier than the gas heated ingots. On those ingots which were finally finished in an 18-in. continuous mill in series with the blooming mill, the recording meter showed a reduction in electrical peak loads on the mill drive running up as high as 25 per cent in some cases and averaging consistently below the peaks on the gas heated ingots.
>
> "The results of our experiments have demonstrated in a practical way that ingots can be heated electrically and in a manner which will insure almost ideal performance when going through the rolls in the mills. If proper heating of ingots will help in the minimizing of "tears", aggravated in rolling, then there can be no question about the efficiency of this method. This, taken with the decrease in power to roll, together with the reduced wear and tear upon the mechanism of the mills, are factors of great importance and have a very direct bearing on the final cost of the resulting products rolled. Then again the decreased loss in scale is a consideration of very great value and, in heating certain classes of material, would no doubt be of paramount importance, especially in the puddled iron industry."

The results so far obtained are in a way experimental, but with improved design of furnace, there is no doubt that an electrical soaking pit can be designed to give ideal heating conditions and at cost that will compare very favorably with other methods of heating.

I commend Mr. Butler's summing up of the furnace to your readers, "that an electrical soaking pit can be built which will give almost ideal conditions of heating ingots and at a total cost which will compare favorably with many heating costs. It is entirely probable that further use of this method of heating would unfold further refinements which would lead to quite a general use of electric heating. In any event this method of heating has unlimited possibilities and represents a distinct contribution to the art of preparing ingots for rolling."

Electric Heating of Cast Ingots Immediately After Casting.

Another new use of electricity in metallurgy is the electric heating of cast ingots immediately after casting, in order to keep the metal fluid and prevent blow holes, etc. This is now being done by the International Nickel Company, Huntington, W. Va., and a detailed description of the process was given by Mr. F. C. Watson, Electrical Engineer of the company before the Pittsburgh meeting of the Iron and Steel Electrical Engineers, Wm. Penn Hotel, Saturday, December 12, 1925.

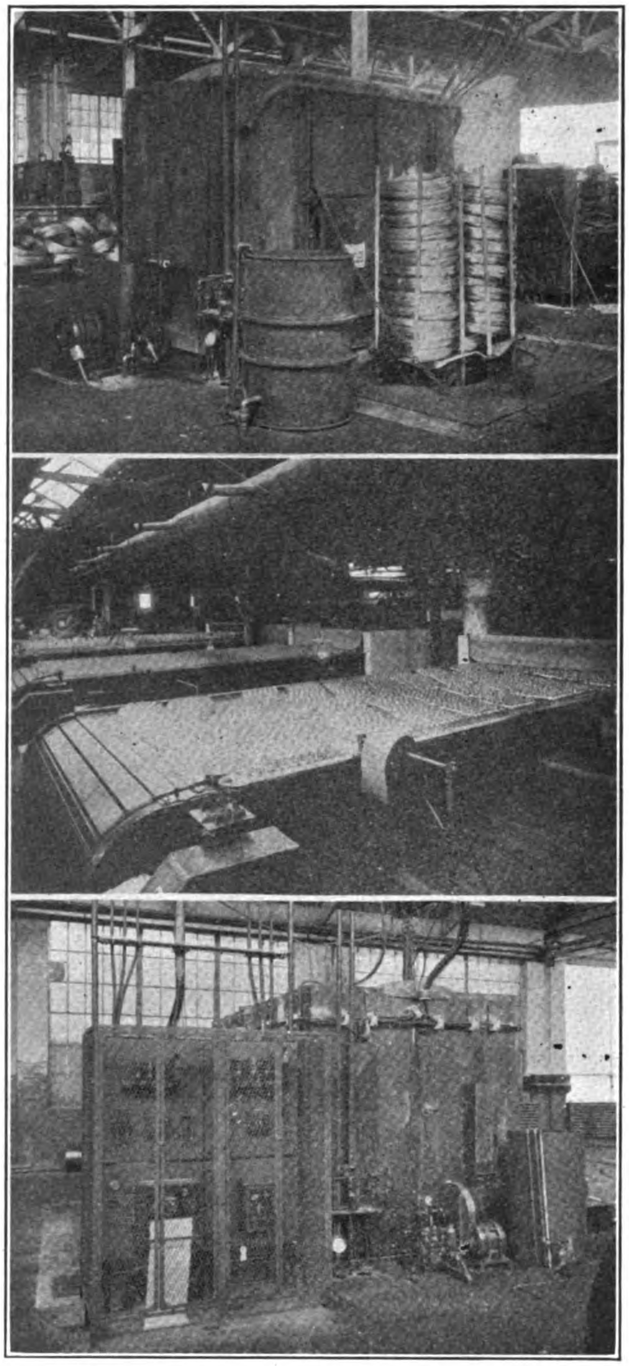

FIG. 2—*Top, electric furnace for bright annealing of copper wire.. Middle, battery of three electrically heated glass lehrs. Lower, instrument and control panel for electrically heated vacuum impregnating tanks.*

Hot tops for ingots have been used for a number of years. The old method, of course, being to heat up the refractory top to a high temperature, which would serve to keep the metal fluid for a certain length of time. In England and Europe considerable **use has been made of metallic permanent hot top for** ingots invented by Mr. Roland Village. This particular form of top can be heated by gas, oil, coke, or other similar fuel and it has given exceptionally good results. The use of electricity however, in the form of arcs playing on the top of the ingot appears to be a much better solution of the problem as this will ensure the top of each ingot being kept in a liquid state so that all holes and cavities formed in the ingot during the shrinkage in cooling down will be fed from the main top of the ingot. Viscount Chetwynde, an English metallurgist, patented and operated a somewhat similar process on large gun ingots some years ago.

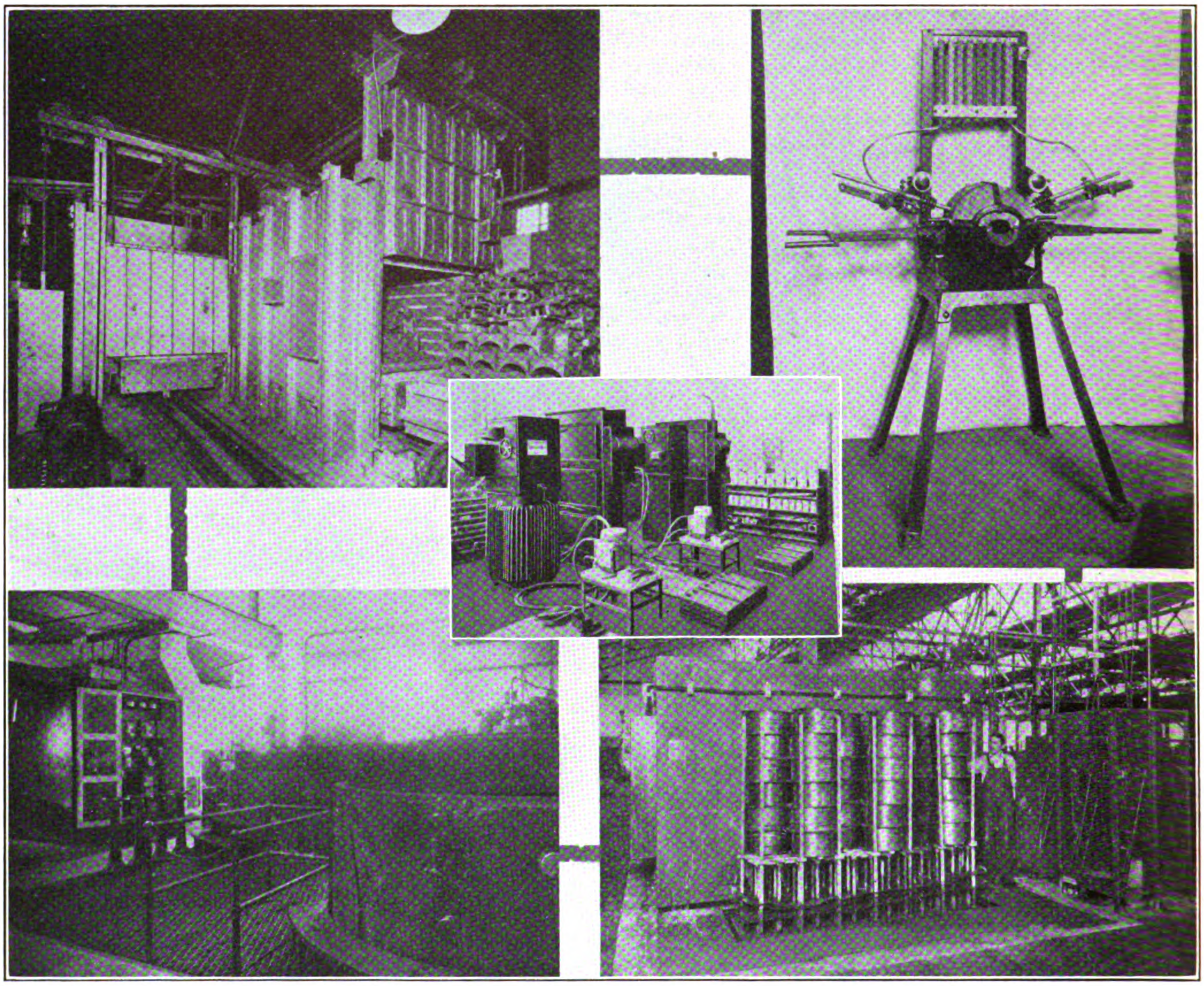

FIG. 3—*This assembly of five widely different applications of electric heating illustrates the great variety of furnaces which have been developed to meet expanding needs. Note the large steel casting annealing-furnace at Nugent Steel (upper left), Booth Arc furnace (shown at upper right), Ajax High Frequency Crucible furnace (centre), vacuum tank and Kenworthy copper annealing (lower).*

The year 1925 has seen a real extensive use of electricity in the oil industry, but I regret that very little information has been given out concerning the results achieved. There is, no doubt, however, that results have been satisfactory and will open up an entirely new field for electric heating.

The Use of Electricity in the Glass Industry.

The use of electricity in the glass industry, particularly in the annealing is now an established fact. An excellent paper was given by Mr. Kenneth M. Henry, Chief Chemist of the Illinois Pacific Glass Company, San Francisco, Cal., in the Glass Industry, August 1925, under the title of "Annealing Glass with the Electric Lehr." Mr. Henry and Mr. Rosenstein, Vice President of the Illinois Pacific Glass Company, have done notable experimental work in this direction. By their permission, the middle view of Fig. 2 shows installation of such a furnace. It is interesting to note that the entire output of this bottle factory is now electrically annealed. One of the chief advantages claimed for this process of annealing, which has been patented, is the close control of temperatures following definite time temperature curves that have been scientifically determined. These furnaces all use metallic resistor elements of nichrome, and they are automatically controlled by Leeds & Northrup Controlling potentiometers.

The Illinois Glass Company, Alton, Ill., have recently installed an electric lehr in their plant, furnished and designed by the Illinois Pacific Glass Company and I am advised that its operation has been entirely satisfactory.

Continuous Strip Annealing Furnace.

A very interesting new application of electricity to heating has been made at the plant of the Columbia Steel Company, Elyria, Ohio, for the continuous strip annealing of auto fender sheets. No published information has been given out concerning these furnaces, but General Electric Company metallic resistance units have been used and I understand the furnaces have a connected load of 850 kw. and are 70 to 80 ft. long. The furnaces are heated up to 1,850 deg. F. and continuous strips 20-in. wide pass rapidly through the furnace. The time taken by this operation as compared with the older method of box annealing is, of course, very much in favor of the newer method and I understand 12 pounds of metal can be treated per kwh. of power used. The process can be continuous and the sheets pass through a pickling tank if necessary—although it has been found that very little scaling is formed in the electric furnace. There undoubtedly is a large field for electricity in continuous strip annealing for various purposes. One of the first furnaces of this kind was installed by my old company at H. Disston & Sons, saw manufacturers, Tacony, Pa., for continuous hardening and tempering of band saws.

Electricity for Heat Treatment of Aluminum.

The use of electricity for heat treatment of aluminum has made rapid strides and the Aluminum Company of America have quite a number of furnaces now in successful operation, both of the pit and two-chamber type for annealing aluminum. Electric furnaces have also been supplied for the annealing of aluminum foil.

The Western Electric Company, Chicago, have an interesting electrically heated furnace for the Bower-Barff Process. The Western Electric Company have not yet given out any information on this furnace, but probably at a later date some of their own engineers will submit data and information for publication.

An interesting furnace has been supplied to the Frankford Arsenal for the annealing of cartridge shell cases. This furnace was designed by the Rockwell Company and details will be published at a later date.

Electric Annealing of Tool Steel.

Another interesting application of electricity has been that for tool steel annealing, usually in boxes, and where the product is cooled in the furnace. This is usually done at a temperature around 1,650 deg. and it is claimed that slightly higher cost of annealing is more than compensated for by the absolute uniformity of the annealing, due to control of temperature and control of the rate of cooling. The bars also have considerable less scale than is uually met with in other types of furnace. The Columbia Steel Co. of Elyria, Ohio, have been annealing their entire production of tool steel by electric furnace methods for sometime, but they have no information they would care to have published. Other companies who are using this method are the Vanadium Alloy Steel Company who have promised in a very short time to give full information of their experiences in this type of equipment, the Firth-Sterling Steel Company, Simonds Saw Company, and Bethlehem Steel Company.

A certain amount of work has been done on roller hearth type of furnace and a few new installations have been made.

There is, in the writer's opinion, a promising field for the use of electricity in carburizing furnaces of the retort type. A number of furnace manufacturers are now working on this problem.

Rotary Type of Electric Furnace.

The rotary type of electric furnace originally introduced by the Geo. J. Hagan Company continues to make very good progress, and is being widely used in the automobile industry. Types of these furnaces are no doubt well known to the readers, and it is not necessary in this article to go into details concerning same. Briefly, they are based upon the principle of annular ring rotating about a vertical axis. Metallic heating elements on the sides of the chamber rotates heat to all parts of the hearth. Small parts, such as rocker arms, steering arm balls, idler gear shafts, piston pins, spring bolts, steering knuckle pins and other small motor parts are placed in trays. The average heating time of such articles is around 45 minutes, and the normal output of the furnace per shift with a temperature of 1,650 deg. F. is 13,000 lbs. The manufacturers state that in the Milwaukee plant of the Nash Motors a rotary furnace of this type cost, including operating and power at .009 per kwh. and labor at 60c $.00157 per lb. of steel treated. The work is inserted through one door and after making one complete circuit of the furnace is removed through the second door.

Electrically Heated Furnaces for Annealing Non-Ferrous Metals Without Oxidation.

Considerable interest is now being shown in the use of electrically heated furnaces for annealing non-ferrous metals without oxidation. Charles F. Kenworthy & Company, Inc., have been very successful with this type of equipment which uses metallic resistor elements. The furnaces installed have been usually of the car type or of the rotating elevator furnaces. They have been used largely for the annealing of copper wire and for the annealing of nickel silver. It is claimed that the product is uniformly soft, clean, and free from oxidation, of high ductility, and takes on a much smoother and better finish than is possible by any other method of annealing. The annealing chambers of this furnace resemble large inverted bottles with their mouth sealed in tanks of water over which the entire heating unit is set. The product to be annealed is carried into the chamber by means of hydraulic elevators operating in the water sealing tanks. In the car type furnaces, two elevators are employed, a single heating chamber being alternately moved back and forth by hydraulic power before and in proper reach of the elevators, one of which is raised and supports a load of metal to be annealed while the other is being unloaded and reloaded. In the rotating type furnace, one elevator only is used, which with its four platforms, set in radial arms is located in a circular sealing tank over which the heating chambers are set with their centers on the path of radiation in the elevator platforms. The Fig. 2, top view, shows furnaces installed by the General Electric Company for annealing of copper wire. All the copper wire used by the General Electric Company at this plant is now electrically annealed. Fig. 4 illustrates a through section of the Kenworthy car type electric annealing furnace. Ten Kenworthy electric non-oxidizing furnaces have been installed during 1925 ranging in size from 90 to 355 kw.

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Small Electrically Heated, Tool, Drawing and Hardening Furnaces.

The Leeds & Northrup Company of Philadelphia, who have done very notable work on recording controllers for electric furnaces have supplied a large number of their small electrically heated, tool, drawing and hardening furnaces. Their 1925 list shows that up to the end of October 1925, 163 furnaces have been installed and sold. One of their latest developments is the new Homo Electric drawing furnace.

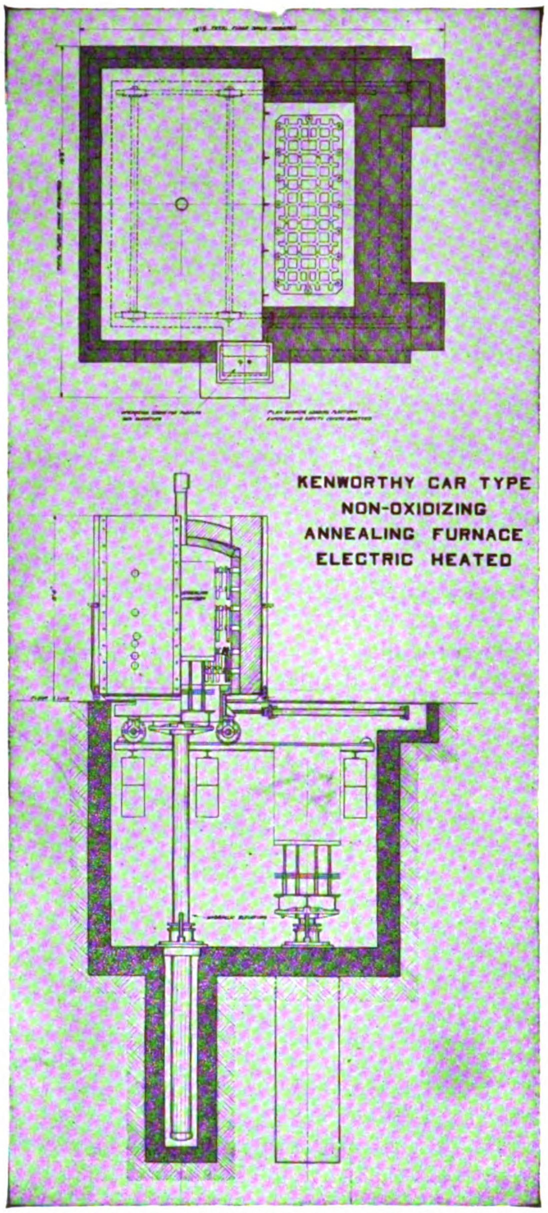


FIG. 4—*Two views of the Kenworthy car-type non-oxidizing electric annealing furnace.*

The source of heat in this furnace is electrical, but by an arrangement of fans, air is made to circulate over the heating coils, so that actual heating medium is heated air.

A basket containing work is lowered inside a cylindrical wall which forms the inside of the furnace. The basket is open at the top and its bottom is in the form of a heavy grid. The fan is placed below the basket and is driven by an external motor that reverses automatically. Between the inner wall of the furnace, which closely surrounds the basket, and the heavily insulated outer wall is an air space. In this space heating coils of nickel chromium wire are supported between insulating clamps. The fan, reversing at short intervals, drives the air up through the coils and down evenly through the load, then down through the coils and up through the load.

The chief feature of this furnace seems to be that direct radiation of heat has been eliminated and the rapid circulation of air in alternate directions gives very uniform heating throughout the charge. The heating is also bound to be very uniform in all parts of the furnace.

High Frequency Inductive Heating Furnaces.

Considerable work has been done in the development of the high frequency inductive heating furnaces, under the Northrup patents, controlled by the Ajax Electrothermic Corporation of Trenton. These high frequency furnaces have been used extensively on a laboratory scale for the past 8-years but only recently have commercial installations been put into more general use. They have been used chiefly for producing alloys of the nickel-iron, gold-platinum, osmium-iridium, and similar metals requiring high temperatures. They have also been used for melting metals of the tungsten group. The tendency today and the demand for metals of higher melting points, creates a good field for high frequency furnaces for this purpose, where freedom from contamination and perfect homogenity of the metals, together with high melting temperatures are necessary. Furnaces of up to 600 lb. capacity are now in use. Such a furnace will melt a new charge of 600 lbs. of copper strip or scrap in approximately one hour.

Crucible High Frequency Induction Furnace.

An interesting development has been made by the Ajax Corporation in the use and design of new type of crucible high frequency induction furnace which is here illustrated, Fig. 3. Such a furnace should have many applications in foundries and places where small quantities of metal of varying compositions are required. One company have installed 46 small high frequency units in their plant for melting of low carbon iron-nickel alloy.

Electric Recuperative Furnace for Annealing Castings.

One of the first furnaces of this type to be successfully operated was that installed by the Electric Furnace Construction Company for the Yale & Towne Mfg. Company. This furnace was of the double-tunnel type with a heating chamber in the center of each tunnel. Cars containing charges to be annealed moved through the tunnels in opposite directions, thus the car coming out of the electric annealing chamber gives up its heat to the one in the opposite tunnel about to enter the electrically heated zone. Several furnaces of similar type have been installed in other plants, including that of the Walworth Manufacturing Company.

A somewhat different type of electric furnace, but involving a pre-heating, an electric heating, and cooling chamber, for the annealing of steel castings, was installed by the Nugent Steel Castings Company, Chicago. The makers of this furnace are the Hevi-Duty Electric Furnace Company, Milwaukee. The furnace is of 250 kw. capacity and the heating coils of nickel chromium alloy are installed in the side walls and arch. In addition, each car carries 80 kw. of heating units. In other words, one-third of the total installed capacity is placed in the car. There are a total of 4 cars for the furnace, three of them being in the furnace at one time and the fourth one being outside for unloading or reloading. The furnace comprises three chambers, a preheating, heating, and a cooling chamber. The preheating is accomplished through absorption by the cool charge of the heat radiated from the cooling charge, there being no wall between the cooling and preheating compartments. It is claimed that economy in operation is effected and this method also insures slow cooling of the heated charge and continuous operation of the furnace.

The important features of the furnace are recuperation and slow cooling, the control of temperature during annealing and the evenness of temperature in the annealing chamber.

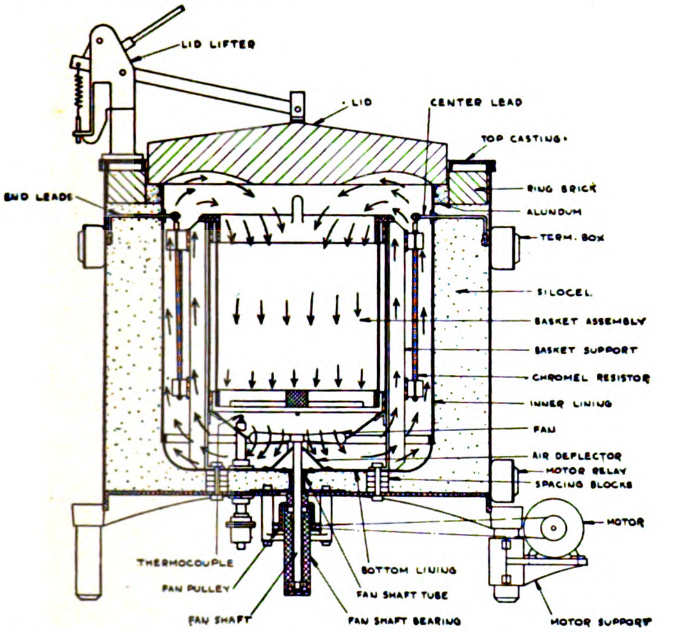


FIG. 5—*The Homo Furnace shown in cross section. The arrows indicate the path of the heating air which is forced in alternate directions, reversing at short intervals. This is responsible for remarkable heating uniformity of this furnace.*

The mechanical operation of the furnace is by motor driven chain mechanism which picks up the cars and moves them the required distance. The arrangements of control are such that the operator controls from one position and one operator can make any or all of the car movements. Electric interlocks are provided on the furnace and the power input in the furnace can be changed by a series of reduced capacity switches on the control panel. Mr. W. J. Nugent, General Manager of the Nugent Steel Castings Company informs me that the power consumption runs from about 170 to 300 kw. per net ton of castings, depending on the size of the load and the rate at which they operate the furnace. A detailed description of this furnace, which can be taken as typical of a modern electric annealing furnace, was read at the American Foundry Association, Pittsburgh, June 13, by Mr. L. E. Everett of the Nugent Company.

Non-Scaling Furnaces.

Attention is now being given to special design of electric furnaces where air can be totally excluded and some inert gas, such as nitrogen, substituted. The writer believes that such a furnace will ultimately solve the problem of scaling during heat treatment. Designs have already been worked out for a number of such furnaces but no practical results are available at present.

Standard Arc Melting Furnace for Steel and Iron.

In the standard arc melting furnace for steel and iron, progress has been steady along established lines of design. A number of new installations have been made and there is undoubtedly a tendency to use an electric melting furnace more largely for the manufacture of high grade iron. Cupola metal has not changed very much in the last 1000 years and the makers of modern machinery and equipment are beginning to realize that an electric furnace will give a much higher grade of iron, better physical properties and uniform composition than is possible in cupola furnace product. The use of electric furnaces in the iron industry also permits the use of alloys to prevent corrosion and to increase physical strength. The General Motors Corporation are installing a battery of electric furnaces for foundry work and the Ford Motor Company already have quite a number of electric furnaces including the 60-ton Greaves-Etchells melting furnace put in operation this year. Only a limited number of electric melting furnaces have been installed for tool steel, but this is more due to the fact that the country is only just catching up to the war production of tool steel and not to the fact that electric furnaces are not now recognized as the method of making tool and alloy steel.

Steel Castings.

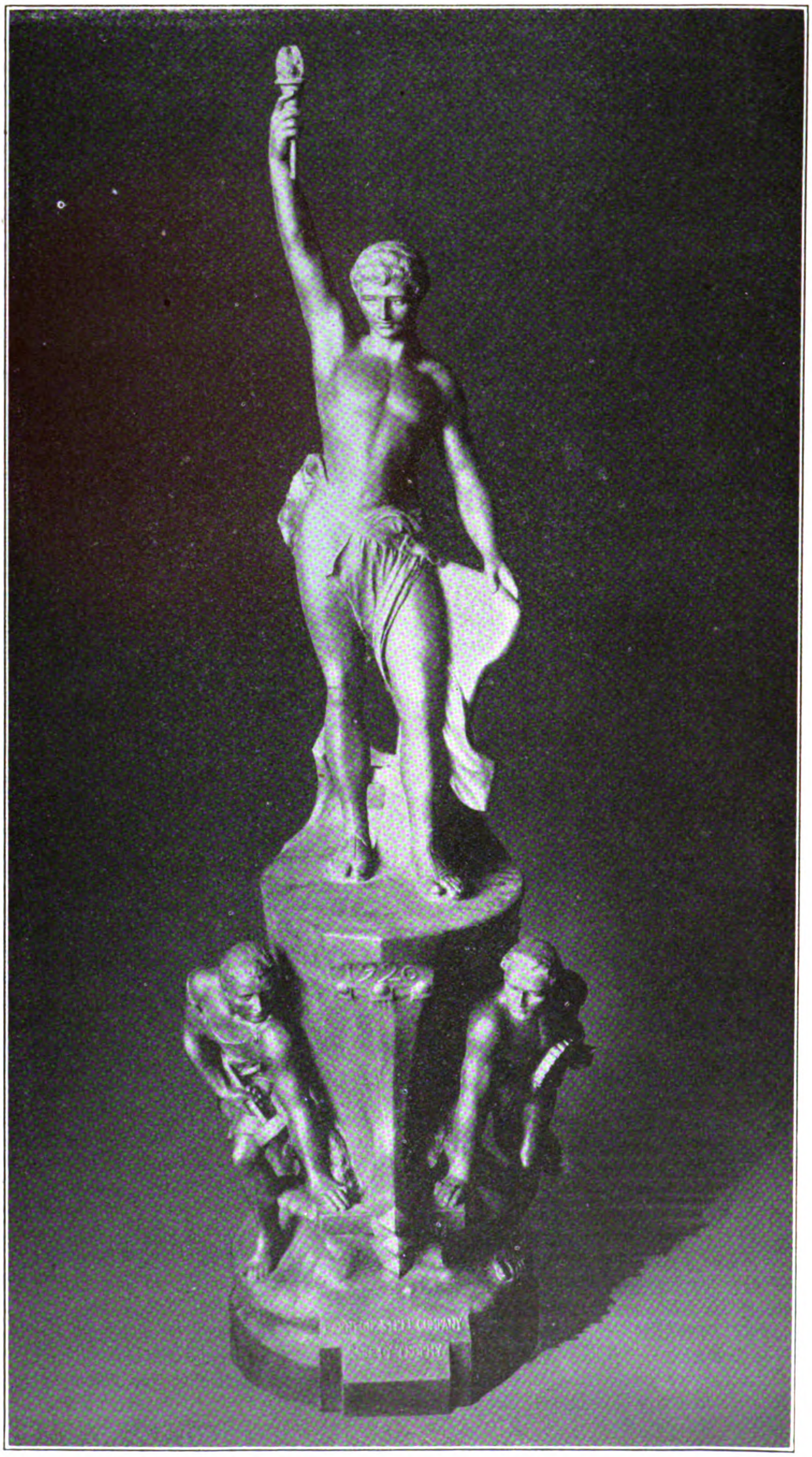
A large number of smaller electric melting furnaces of the arc type have been installed for the manufacture of steel castings. Most of these have been of the acid type, as it seems that the acid steel casting is the only one that can compete in price with other processes for making steel castings. There is a growing tendency today to standarize on the manufacture of electric acid steel castings in a similar way to what has already been accomplished in the malleable iron industry. Undoubtedly, one of the chief objections to the use of electric steel castings has been the lack of uniform practice in the different plants. The metal from one plant would usually be totally different than that received from some other foundry, so that the buyer could not really know what he was going to get when he specified electric steel castings. Standardization of electric steel castings whether acid or basically made would do much to extend their use.

The Reading Steel Casting Company of Reading are installing a furnace designed by Mr. E. T. Moore in conjunction with Mr. Crafts of the Reading Steel Company that has several novel features, although the main principle of heat application remains the same.

A high temperature smelting furnace suitable for laboratory work and one that it is claimed will melt up to temperatures of 3,000 deg. C. has been introduced by Drying Systems, Inc., Chicago.

The Booth Electric Furnace Company, Chicago, have done considerable work this year in developing small electric arc furnaces, a large number of which have been installed at laboratories and plans requir-

(Concluded on page 108.)



The story of the creation and development of the Carnegie Safety trophies, of which this is the fifth is told on the opposite page.

THE SAFETY CRUSADE

The Dream Ship—Destiny

Moretti Has Caught the True Spirit of Safety in the 1926 Carnegie Trophy

By W. H. FRENCH*

FOR the fifth consecutive year the Carnegie Steel Company has put into competition among its plants, a beautiful bronze safety trophy which eventually will become the permanent possession of some one of its plants, by reason of excelling in safety work. The thought of safety on a competitive basis was inaugurated by this company five years ago, when the bronze trophy was decided upon as a goal for which to strive. The idea met with such enthusiasm among the employes that it has been continued from year to year, and as a climax to the allegorical stories of the various trophies, this years-trophy is larger and carries somewhat of a story of reaching a goal.

These trophies are competed for from month to month during the year, a plant making the best record, for one month, holding it for the succeeding month. At the end of the year the trophy is awarded in perpetuum on the year's record. It was considerable of a problem to work out a basis upon which the competition could be carried on and do justice alike to the small as well as the large plant, and after much study it was decided that each plant or unit should compete with its own previous record. And so now the prize is a awarded to that plant making the greatest percentage of reduction in lost time accidents over its own previous record for the same month during the previous five years, and likewise, the yearly record is compared with the record for the plant during the previous five years.

The 1925 trophy just has been awarded to the Youngstown, Ohio, District of the Carnegie Steel Company. This includes the Upper and Lower Union Works and the Ohio Works at Youngstown, and the McDonald Works at McDonald, Ohio. The Youngstown District won the trophy over the 10 other competing units with a reduction of lost time accidents during the year, of 75.74 per cent over the preceding five years, a record that is remarked by safety men, when the magnitude of these works is considered.

Similar heavy reductions in lost time accidents were made by other plants such as Farrell Works at Farrell, Pa., with a reduction of 63.03 per cent; Clairton Works with a reduction of 54.51 per cent; Duquesne Works, at Duquesne, Pa., with 50.59 per cent; New Castle Works, at New Castle, Pa., with 42.85 per cent reduction; Homestead Steel Works 42.85 per cent; City Furnaces, the blast furnace units in the city of Pittsburgh, 39.49 per cent reduction; Edgar Thomson Works at Braddock, Pa., 35.89 per cent; Mingo District, the units at Mingo Junction, Steubenville, and Bellaire, Ohio, 27.72 per cent; City Mills, the oldest units of the company, and located in the city of Pittsburgh, 23.31 per cent reduction and the interplant railroad, Union Railroad, 20.20 per cent reduction.

The trophies previously in competition are now held by various plants as the permanent property of that plant. The first one awarded for the year 1922 was won by the Edgar Thomson Works; the next two, those for 1923 and 1924 were won by the Farrell plant, where they are now placed in most artistic recesses made of concrete as part of the main gate to the plant, and displayed behind protective glass. Here they are spectacularly lighted at night so that all may see as they pass—an object reminder of safety at all hours of the day and night.

The 1925 trophy is to be presented to the men of the Youngstown District at a large mass meeting that is being arranged at which officials of the company are to be present.

All the trophies are the work of an eminent sculptor, Guiseppe Moretti, who now makes his home in Florence, Italy, and makes periodical visits to this country. Each has its own story of the composition and that of the present one is based on the old expression of one's ship coming in.

In the secret heart of every individual there is some Dream Ship of idealism, love, ambition, wealth or whatever that soul most desires. He eagerly and secretly, sometimes unknown to himself, desires the coming of his Ship. This trophy has been built around the Dream Ship, Destiny.

The sculptured design is strong, impressive, and easy to understand. Its lesson is directly to the mind, the heart, the imagination. The eyes of the holder are drawn again and again to the beauty of pleasing lines and masses, and swift motion arrested; meantime the theme appeals to the conscious and the subconscious mind.

A large ancient galley ship is seen. The type is happily chosen both for its beauty and because the galley was moved by direct human effort. A tall beautiful youth stands on deck holding a rudder bearing the words "Safety First". In his right hand he holds aloft a light. The Youth is the Light Bearing ideal. In the shallow water on either side of the home coming ship are two splendid running figures. They are Labor and Industry, pushing the ship into landing. The ship is the spirit of Destiny. It has great sweeping wings on each side for it moves in earth, air and water and penetrates the mind of man in every position, in every place, and under all circumstances.

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*Safety Department, Carnegie Steel Co., Pittsburgh, Pa.

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Hard Spots on Steel Forgings

Summary of Careful Investigation of the Phenomena Connected with These Formations

By JOHN D. GAT*

IN a vast majority of forge plants there is always a possibility of encountering trouble, small and unimportant by itself, but introducing a discordant note in an otherwise perfectly running organization and often persisting disregarding the best efforts for its elimination—"Hard Spots" is one of them.

The characteristic features of this defect are fully described by the title, and the discovery of these spots usually coincides with the rapid wear of the cutting tools during the machining of the forgings. This seems to be a safer, though more expensive, way of finding hard spots because only a very close inspection, not available as a general rule in production work, can locate a hard spot on the surface of a forging after it leaves the finishing die. There is no difficulty in finding them on a surface machined or cleaned with acid, Fig. 1. The "hard spots" are "shinier" and have tool marks of different character than those present on the surrounding soft metal.

Spots Not Due to Segregation.

A sharp line of demarkation has to be drawn between hard spots and segregations sometimes found in high carbon, high alloy steels. They are totally unrelated and their origin can be traced to quite different causes.

The writer, belonging to the technical staff of an organization engaged in the manufacture of alloy steels, a large part of which is afterwards subjected to forging, had an opportunity to study the phenomena connected with the formation of the hard spots in many plants and under very diversified conditions. This permits him to make certain generalizations, advance some of the facts as a basis for further investigations and, after establishing the cause of the trouble, to recommend means for its elimination or, rather, prevention.

Hardening of the small areas of the surface does not take place in the plants where articles are not subjected to any kind of thermal treatment. Hard spots cannot be associated with any definite type of steel, and manufacturers cannot trace their origin to a particular shipment of material or changes in forging practice. They do not appear at any time in comparatively large numbers or come from a given furnace. They are never numerous enough to affect to an appreciable extent the production of a plant, are similar in all forge plants investigated and are exciting considerably more attention than they deserve because of a veil of mystery which seems to surround them.

Their name emphasizes their most pronounced feature, relative hardness. Rockwell readings taken on them usually vary between 30 and 40 and are not affected by the heat treatment which a forging is liable to receive under normal conditions. The hardness is not constant but varies, which is clearly shown on cross-sections of hard spots. Rockwell readings rapidly diminish from the outside to the center of forgings. The maximum value is found on the surface and is represented by the quoted figures, while the minimum depends on the kind of steel of which the forging is made. The latter value is, properly the hardness of steel itself and is introduced only to permit a closer study of the variations of the hardness in a spot which can be easily demonstrated by the appearance of an etched cross-section of it. The extreme edge is usually not attacked by the etching reagent, then the coloration reaches suddenly its maximum, gradually losing its intensity until the shade of the etched metal of the forging is reached. Omitting the white edge, the color and hardness go hand in hand.

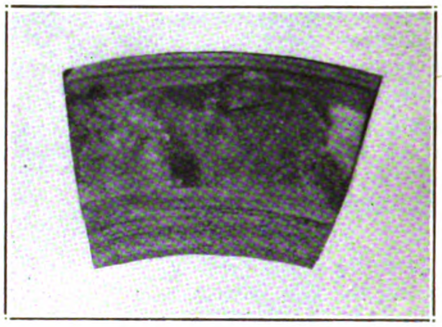

FIG. 1—*Hard spot as seen on a forged gear blank, natural size.*

These simple observations lead to clear and logical conclusions. An area of the surface, corresponding to a hard spot, becomes in some way enriched with an element having a hardening effect on steel, and this effect diminishes towards the inside of a forging inversely proportional to the amount of diffusion of the hardening substance, which is carbon as can be seen from Fig. 2, representing the outer layer of a typical hard spot.

Hard Spots Resemble Cast Iron.

Under a microscope a hard spot appears as a flake of cast iron adhering to the surface of a forging and, usually, having part of its carbon diffused into the metal surrounding it. This picture is prone to have innumerable variations as a result of an unlimited amount of possible changes in the surrounding conditions. The fact that every hard spot starts with a flake of cast iron is strongly supported by the evidence.

Though the presence of areas rich in carbon in hard spots is, after being conscientiously acquainted with facts, a postulate, it is difficult to account for their origin. Leaving for a moment the theoretical aspects of the question alone we may approach it from two main avenues: The formation of hard spots during processes connected with the manufacture of steel or their generation in forging plants, i.e., starting from the point of view of a maker or user of steel.

Two factors always stand sharply before the eyes of a steel forger—hard spots have all the earmarks of cast iron and always appear on the surface only,

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never inside of a forging. It is but natural to attribute the defect to the lack of proper care in making or handling of steel in the mills resulting in introduction of cast iron in it, and to blame the steel manufacturer.

This actually happened several times and resulted in a long and thorough study of all stages of steel manufacture before any reasonably well based conclusions could be reached.

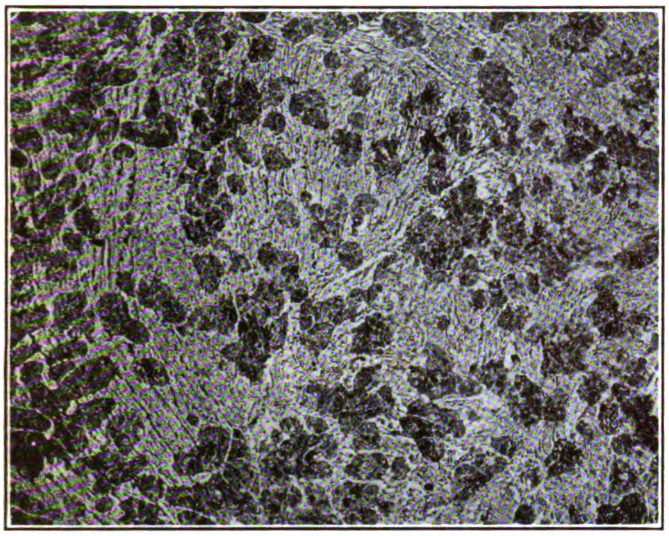

FIG. 2—*Outer part of a typical hard spot.* x100.

To procure data less influenced by conditions which may arise in case of an individual heat, many were closely followed from the scrap yard to the moment they left the plant and all the details of processes recorded and analyzed. This was the first stage of the investigation. The second consisted in the study of the conditions prevailing in the forging plants which used the heats so followed during their making, and of the results obtained when these steels were forged.

No Contamination From Ingot Moulds.

The period previous to tapping and between it and teeming of the metal in the molds can be totally disregarded. Cast iron, which might find its way into a ladle, cannot exist as solid masses in liquid steel during 20 minutes usually spent between the beginning of the tapping and teeming of the first ingot. If contamination of steel with cast iron takes place when the metal is still molten, it can occur only in the molds where there are two sources of cast iron, the mold itself and the cast iron plug used as a stopper in Gathmann molds. If a mold is very badly worn, a particle of its wall can be washed away by the steel, or cast iron overflow on the plate of a plug may act as a source of it if broken off when the plug is placed carelessly into a mold. Fig. 3 shows such an overflow as it appears on the plate of a plug.

No contamination with the metal from the mold itself took place during all of the heats that followed. The closest inspection possible guaranteed that only molds in excellent state of repair were used and this was checked by a second inspection after stripping. None of them were found to have defective walls.

The subject of the possibility of contamination with cast iron broken off from a plug needs a more detailed explanation. At the first glance it may seem that a thin plate of cast iron laying on the bottom of a mold can easily be picked by the whirling stream of steel during the first moments of pouring and on solidifying fixed somewhere in the lower part of an ingot. Carburizing effect of such a piece will be fully developed during many hours at heat before rolling and will result in carbon segregation in finished bars. It was interesting to check this possibility as far, at least, as the distribution in ingots was concerned. For this pupose, cast iron plates about ¼-in. thick were placed on the bottom of several molds and the steel was teemed on them as usual. After stripping, the ingots were cooled, split longitudinally and examined for the presence of cast iron inclusions. In no case were the plates frozen more than a very few inches above the bottom of molds and often only a fraction of an inch above it. The cooling in the lower part of an ingot is so fast that only a very slight fusion of the surface of the inclusions could be seen, which of course cannot prevent the completion of carbon diffusion in soaking pits, though there still will be no carbon rich areas in the finished product because each ingot is cropped at the bottom at least 12 in. Furthermore, they would be present mostly in the body of the metal instead of being on the surface as it is observed in actual practice.

Heating in the Soaking Pit.

When the question of cast iron inclusions in liquid metal was sufficiently illuminated, the next stage of the processing, heating in soaking pits, was approached and found to be totally irresponsible for carbon contamination. Though the flame in soaking pits, oxidizing as a general rule, could, under some abnormal conditions, become carburizing, it cannot be held responsible for a very strongly localized heating in this type of furnaces where the flame does not directly impinge on the surface of the ingots. The placing of coke on the bottom of them creates some danger of contamination but the inevitable croppage removes all undesirable effects of the contact.

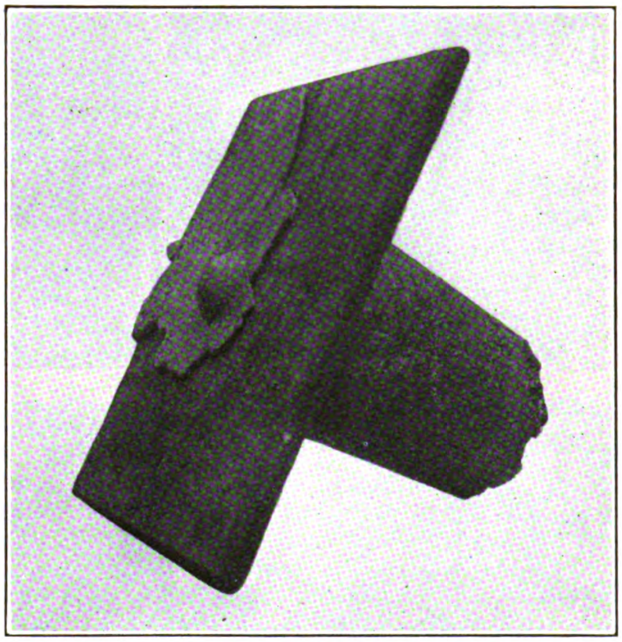

FIG. 3—*Cast Iron plug used in Gathman molds. Note cast iron overfill on the plate.*

Reheating for final rolling, following the conversion into billets, is performed in automatic gas-fired furnaces where the billets travel fast, the temperature is moderate and the atmosphere slightly oxidizing. No carbon can reach the billets unless intentionally thrown on them, so that the danger of carburization is reduced here to a minimum. The only chance for a bar to pick up a piece of cast iron would be rolling in of some loose piece of metal present on the rolling floor or a piece chipped off the rolls, possibilties in which nobody even distantly acquainted with rolling mill practice would believe any more than in a statement of a metallurgist who once publicly discovered that the hard spots are due to the salt used on the breaking rolls of a finishing mill.

Billets Carefully Inspected and Chipped.

It is necessary to mention that each bar is inspected and chipped or ground at least twice, after the rolling of billets and when the bars are finished. Though, as it was already mentioned, it is not easy to detect hard spots on a superficial examination, a close inspection by an experienced man would quite probably disclose them, especially if the surface is ground. Heats discussed in this paper were inspected by picked men. Still not a single hard spot could be found on any of the bars from lots weighing many hundred tons. To be certain, the company went even further. On one occasion, when the complaints from a forging plant using a considerable amount of steel became too numerous and the inspectors still were unable to find a hard spot, it was decided to pickle and reinspect a whole shipment—something like 1,000 tons of 1½ -in. rounds.

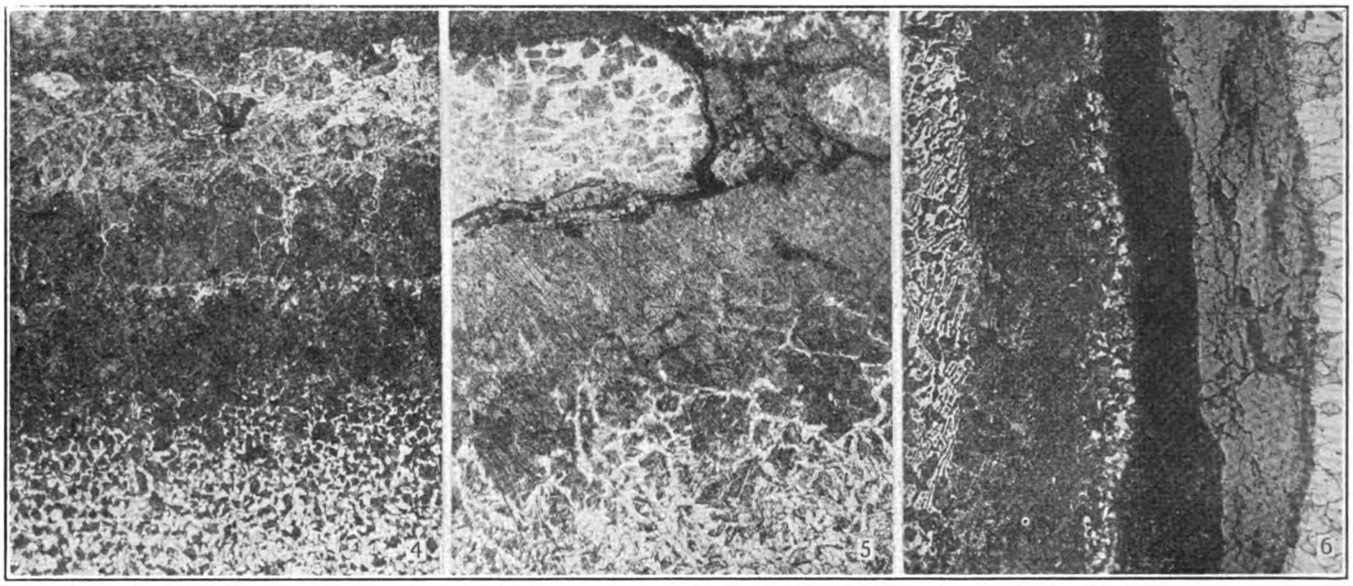

FIG. 4—*Hard spots with carbon content gradually decreasing inwardly.* x100. FIGS. 5 *and* 6—*Hard spots with the carbon content changing abruptly due to the presence of scale.* x100.

This was done according to the instructions. The inspectors were powerless to find the desired defect; the company spent extra money and the forging plant reported that this particular shipment had even more hard spots than usual.

After this, it was rather difficult not to be convinced that hard spots do not originate in the manufacture of steel but are produced in forging plants.

During forging, understanding by it the whole set of operations to which a piece of steel is subjected until it leaves the plant as a finished article, there are two possible places where hard spots can be formed. In the heating furnaces a blank is liable to pick up a piece of cast iron, or the latter can be forged in it under a hammer of a die, still assuming that the defect discussed is caused by this material. The second alternative seems to be more approachable and was studied at the beginning. It was found, after personal supervision of the forging of thousands of blanks that a forging never comes in contact with particles of cast iron which could be driven into their surface by the blows of a hammer, at least in none of the forging plants visited. No local carburization can be produced by occasional dropping of oil on hot forgings or by accidental placing in pools of this material because the time element is very limited.

Possibility of Contamination in Heating Furnaces.

Heating furnaces offer a larger field of possibilities for contamination with carbon, though even here the situation is not simple. Cast Iron is usually excluded from the inside of heating furnaces at least in the form of small particles suitable for adherence to a blank to be forged. An explanation can be advanced based on the practice of some forging plants to throw a few shovelfulls of cast iron shavings on the bottom of their furnaces. In such a case a heated blank may fall down and, being comparatively pasty, pick up a chip or so which subsequently would be forged in with the formation of a hard spot.

This theory served as a basis for investigations for a considerable time, though being strongly objected to by the shop men, and was discarded only when a closer study of iron-cast iron system threw some additional light on the subject. It was already mentioned on the previous pages that a hard spot usually includes an area, the appearance of which is quite similar to cast iron as it can be seen from Fig. 2. This area is found on the outer edge of a hard flake and has a higher carbon content, which then diminishes inwards, sometimes gradually (Fig. 4), sometimes, especially when some scale is present, more abruptly (Fig. 5 and 6). This suggests the

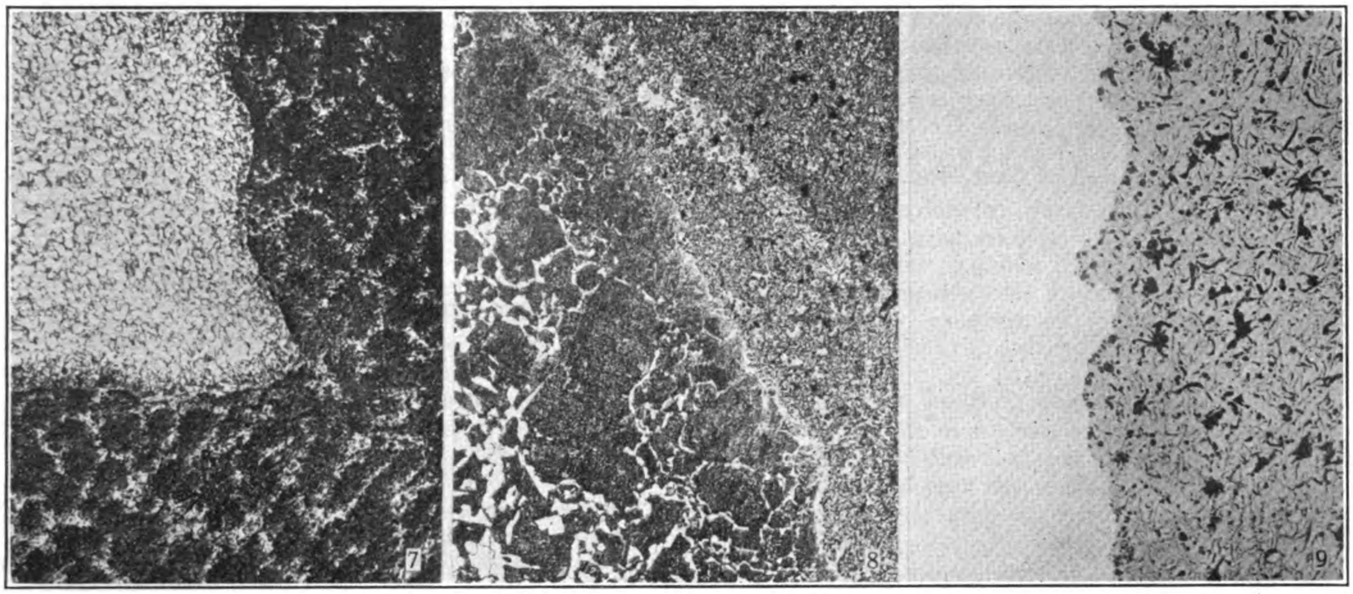

FIG. 7—*Cast iron forged into soft steel. Unannealed.* x100. FIG. 8—*Junction between iron and soft steel after annealing.* x100. FIG. 9—*The plane of contact between forged in cast iron and soft steel. Unetched.* x100.

artificial reproduction of a hard spot to permit the study of the behavior of cast iron in contact with steel under more favorable conditions than these afforded by natural hard spots. Forging of a piece of cast iron in steel will theoretically produce the same appearance as observed on the hard spots, provided the thermal treatment of both will be indentical. With this in mind, several pieces of white cast iron taken from the plate of a mold plug, Fig. 2, where the chilling effect is very pronounced, were forged cold into properly preheated bars of mild steel and the forgings produced were allowed to cool in air. Microscopical examination of them showed a structure quite dissimilar to that usually observed on the hard spots, as can be seen from comparison of Figs. 3-6, with Fig. 7. This difference might be explained as a result of insufficient thermal treatment because a piece of cast iron might come in contact with a forging blank while it is still in a furnace and therefore be subjected to some heat treatment before forging. To reproduce these conditions, experimental forgings were heated in an ordinary heating furnace at 2,200 deg. F. for four hours, cooled in air and examined.

The very first glance at Fig. 8 shows that the structure of a specimen so treated is quite different from that usually observed on the hard spots. Though carbon migration unmistakably takes place, it does not produce successive zones of diminishing carbon content with the same sharpness of demarkation as is usually associated with natural spots and, what seems to be considerably more important, a hard spot so produced lacks in carbon content to such an extent that cast iron zone is no more present. This deficiency might be explained as a result of forging in with the cast iron of some scale ultimately consuming some of the carbon of the cast iron, though this theory has to be relinquished after examination of Fig. 9, presenting the same spot as Fig. 8, but before heat treatment.

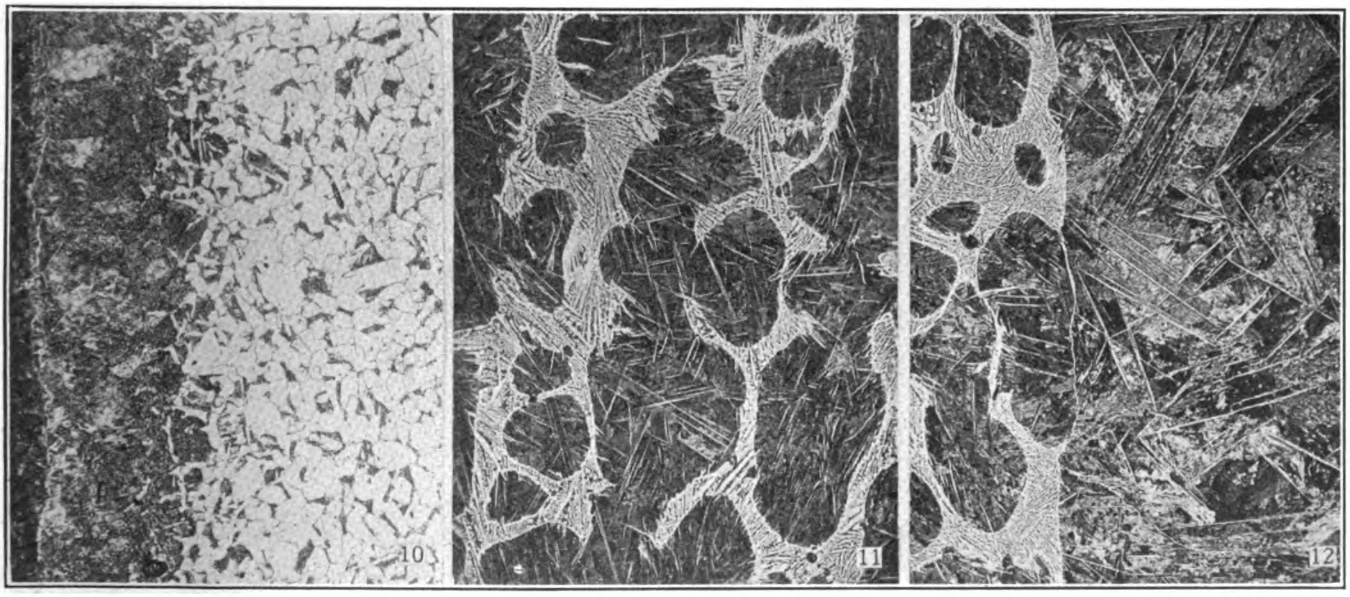

FIG. 10—*Hard spot formed when carburizing substance was not protected from burning.* x100. FIG. 11—*Artificial hard spot. Cast iron core.* x100. FIG. 12—*Artificial hard spot. Hypereutectoid zone.* x100.

The photographs reproduced were selected as representative of many tests with different grades of cast iron, steel and a considerable range of annealing temperatures. Being typical, they are suitable to pave the road to further reasonings.

Not Caused by Particles of Cast Iron.

The study of them tends to indicate that the importance of cast iron for the formation of hard spots is somewhat exaggerated, which is considerably supported by the observation of forging practice. The difficulty of explaining the presence of suitable small pieces of it around the heating furnaces and hammers has to be strongly accounted for and besides it is necessary to pay the most serious attention to the pronounced deficiency of carbon in the artificial hard spots. This points to the fact that the factors connected with the formation of hard spots are more complex than a simple forging in steel of cast iron, followed by annealing.

The solution of the problem would be an easy matter if only it would be possible to establish definitely the possibility of local carburization in heating furnaces. As far as the question stands now, the fuel employed in this type of furnaces, oil, gas or pulverized coal cannot act under normal conditions as carburizers and the problem seemed to be without an answer if a peculiar phenomenon was not observed in a large forge plant.

This plant, having excellent supervision and up-to-the-minute control of all thermal operations, uses oil as a fuel. The burners, to prevent the flame from impinging on the blanks, are directed slightly upwards towards the roof, and the atmosphere in the furnaces, as it would be necessary to expect, is kept slightly reducing. Under these conditions, the combustion is not quite complete and some of the oil deposits on the roof just above the place where the flame hits the latter as soot or, rather, coke because the hardness of it favorably compares with coke oven product. The coke adheres to brickwork but slightly and often falls down. It may remain on the surface of heated objects or covered with blanks placed in the furnace afterwards. In the first case, carburization, though taking place, is slight because, due to rapid combustion of unprotected carboniferous mass, the time element is greatly reduced, and the reaction stops barely reaching the formation on the surface of hypereutectic, or even eutectic alloy, Fig. 10. If, on the other hand, the carbonaceous material is protected in some way, cast iron has time to form and a typical hard spot is produced.

Hard Spots Traced to Carbon Deposited from Fuel Oil.

An experiment was needed to pass from the realm of theories to facts. Some coke was gathered from the roof of a furnace shut down for repairs, and pulverized in a mortar to pass 100 mesh. To reproduce the conditions actually met in furnaces, it seemed advisable not to use a carburizing pot but to introduce the coke between two steel plates similarly to what happens in furnaces. Accordingly, two plates of the analysis used in the plant where the carbon deposit was found, were planed smooth to about 1-in. in thickness; holes 3/16-in. diameter and ¾-in. deep were drilled in the planed faces and filled with coke powder. The plates were coupled, so that the planed faces were in contact and the holes coincided, placed in a furnace with a strongly oxidizing flame and kept for two hours at 2,300 deg. F. After this, they were cooled in air and examined.

The facts proved the theory quite thoroughly. Not only carburization could take place under the conditions of experiment, but the carburizing power of coke was very marked. A short interval of two hours was sufficient to allow the complete absorption of it by the metal, so that the holes were filled with cast iron and a circle of carburized metal ⅝-in. diameter formed around them. The appearance of different zones of this circle was the reproduction of a perfect hard spot, starting with cast iron, Fig. 11, passing through hyper-eutectic, Fig. 12, eutectic, Fig. 13, gradation zone, Fig. 14, and ending with an overheated structure of the steel with the normal carbon content, Fig. 15.

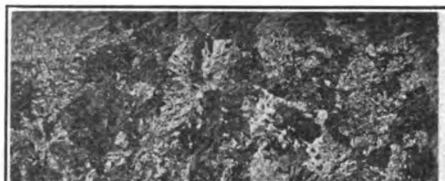
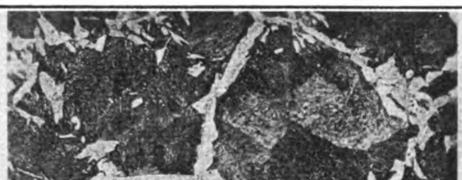
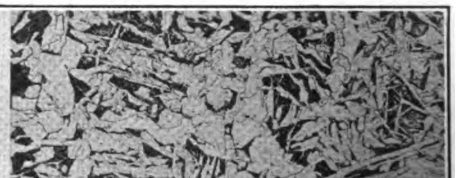

FIG. 13—*Artificial hard spot. Eutectoid zone.* x100. FIG. 14—*Artificial hard spot. Gradation zone.* x100. FIG. 15—*Overheated structure of steel with normal carbon content.* x100.

Eastern States Blast Furnace and Coke Oven Association to Meet

THE February meeting of the Eastern States Blast Furnace & Coke Oven Association will be held in Pittsburgh, Pa., on February 12th. This will be an all-day session with three papers to be read, one in the morning and two in the afternoon:

The following papers will be read before the Association:

"Effect of the Physical Properties of Ore and Coke on the Capacity of the Blast Furnace," by the Bureau of Mines representatives, Joseph, Royster and Kinney.

"An Experience in Serving Two Groups of Blast Furnaces with a Single Coke Plant," by Mr. Dan Rugg of The Koppers Company.

"Selective Segregation of Coking Coal at the Mine and Its Preparation at the Ovens," by Mr. B. W. Winship, Superintendent Steelton Coke Plant, Bethlehem Steel Company.

The regular dinner will be served at 6 P.M. as usual. Further details may be obtained from Charles R. Meissner, secretary-treasurer.

G. H. Charles Elected President, L. G. Pritz General Manager, of United Alloy Steel

At a meeting of the Board of Directors of United Alloy Steel Corporation held recently, Mr. George H. Charls was elected president and Mr. L. G. Pritz, vice-president and general manager of the corporation.

Mr. Edward A. Langenbach, Chairman of the Board of Directors and also President of the Corporation, resigned the latter office in favor of Mr. Charls.

Commenting upon the election of Mr. Charls to the office of president and Mr. Pritz to the office of vice-president and general manager, Mr. Langenbach made the following statement:

"Since the organization of United Alloy Steel Corporation, I have occupied the office of Chairman of the Board of Directors.

"About four years ago I was elected to the office of president with the understanding that at a later date I would be relieved of the additional duties of this office.

"Mr. Charls has for four years successfully filled the position of vice-president and general manager and the Board of Directors feeling that Mr. Charls is in every way competent to perform the duties of president of the corporation, has unanimously elected him to that office.

"Mr. Charls is a man of wide experience in the steel industry and I have every confidence in his leadership and ability to successfully fill the office of president.

"Mr. L. G. Pritz, who, at the special recommendation of Mr. Charls, has been chosen by the Board as vice-president and general manager, has had full charge of the production operations of the plant and his successful services have demonstrated his fitness for the position of general manager.

"I have every confidence in both Mr. Charls and Mr. Pritz and feel that they have merited the recognition for services and advancement that they have received from the Board.

G. H. Charls

Ed. Langenbach

L. G. Pritz

British Iron and Steel for 1925 and Outlook for 1926

A Universal Note of Optimism Is Sounded by Numerous Authorities

By A. C. BLACKALL*

UP to almost the time of writing this review of 1925, the year has been one of the most disastrous in British history for the iron and steel industry, and, as a natural corollary, for those trades dependent on it, partculary shipbuilding and repairing.

There are fortunately, however, now indications of a steady all around revival. It is an old saying that when matters get to their worst they must mend, and although the outlook at the end of the third quarter appeared to be about as black as possible, with the entering into the last quarter of the year there was a decidedly better indication noticeable. The pessimistic feeling seemed on the wane, bankers in their addresses were far more hopeful, the Stock Exchange responded and iron, steel and coal industrial securities, which had for so long been in the doldrums, commenced on an upward curve. Shipping companies' shares followed suit, and all along the line there was a marked appreciation in the value of such stocks. With the exception of the coal trade the number of unemployed is steadily decreasing, notwithstanding that the winter months usually show an increase.

That trade in general is commencing to look up in Great Britain was emphatically borne testimony to in an address given by Winston Churchill, Chancellor of the Exchequer, at the Engineers' Club, recently. The main points of his speech are worth touching upon since any revival in general trade has a very distinct bearing on the future of iron and steel. Mr. Churchill emphasized the fact that in the week immediately preceding his address, there were a quarter of a million less unemployed than in the corresponding week last year, and this reduction has continued every week since.

This decline in unemployment is an omen of great significance, and it is likely the figures will continue the downward trend, said Mr. Churchill. Among other good auguries he pointed out were the following.

Harvests all over the world have been good. The sugar and cotton crops in America have been excellent, and prices have been low. Lancashire cotton industry is flourishing. Manufacturers are able to produce more cheaply, thus enabling our customers abroad to buy more freely. Silk trade has never been better. The Treaty of Locarno will help trade by guaranteeing peace and reducing taxation. The cost of living has diminished. The consuming power of the people has been maintained. The savings of the people in National Savings Certificates have increased by £7,000,000 ($35,000,000) in the present year.

Strong confirmation of Mr. Churchill's optimism is found in the figures compiled by economic experts. They point out that each year since 1921, when conditions were at their worst, has registered an improvement in the volume of business transacted and in the condition of the national finances. The expenses of the National Government during this period have been markedly decreased, and some £533,000,000 ($2,665,000,000) has been paid off the National debt. These expenses have been met wholly by revenue collections, and yet at the same time taxes have been reduced. There has been a marked recovery in the volume of business done, as evidenced by the amount of coal consumed, by the amount of pig-iron consumed, by the tonnage carried by the railroads, and by the evidences of increasing trade.

The Indian Government has granted the necessary authority to the directors of the Great Indian Peninsular Railway for the carrying out of the extensive main line electrification program. The whole of the orders for the plant and machinery required will be placed in Great Britain. This scheme, estimated to involve the sum of £5,000,000 ($25,000,000), is in the hands of a London firm of consulting engineers. Contracts for structural steel work amounting to between $750,000, and $1,000,000, have been secured by Francis Morton & Company, Garston, Liverpool, and these will keep between 300 and 400 men busy from four to six months. The Metropolitan Carriage, Wagon & Finance Company, Ltd., have secured an order to supply 21 all steel carriages for the South Indian Railway. The Leeds Forge Steel Company, Ltd., received an order from the Central Argentine Railway for 60 all steel motor-car and general cargo vans. The Crown Agents for the Colonies have placed a contract with the Horsley Bridge & Engineering Company, Ltd., of Tipton for new pier work extensions at

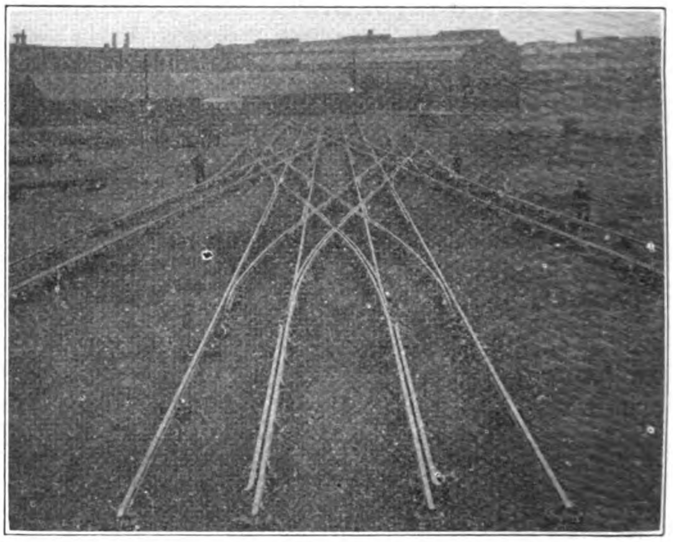
FIG. 1—*Shows the heaviest piece of permanent right of way ever built. Rolled from Era manganese steel.*

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*European Correspondent, London, England.

Port Harcourt, Nigeria, involving 4,000 tons of steel and cast iron work.

Recent Engineering Contracts.

Since the tide began to turn in favor of better trade, some quite important contracts have been landed. One is for the construction of a new harbor at Funchal, Madeira. This involves an expenditure of $10,000,000, all the accessories for which are to be of British make. Some of the largest liners are now calling at this charming port, in their world-round cruises. The new harbor to be built under this scheme will accommodate the largest ships, and will have a depth of water at the quayside at low tide of 25 ft.

A new steel railway bridge across the river Nile is to be built at Dessouk, in the Nile Delta, about 20 miles from Alexandria. The structure is to be a through railway bridge with cantilever roadways and footways at each side.

Having a total length of 2,000 ft., and comprising 10 spans, including one swing span, it is to be built for the Egyptian State Railways by Dorman, Long & Company, Ltd., who will manufacture the whole of the steel work at their Middlesborough works and erect it in Egypt. The contract price is in the neighborhood of $720,000, and the order was secured by Great Britain in the face of severe competition from Belgian, German, French and Italian firms.

Cammell, Laird & Company, Ltd., have secured two important contracts in open competition with American, German, and Czecho-Slovakian firms for 220 broad guage coaches for the Indian State Railways, and 160 coaches for the Bombay and Baroda Railway Company, in connection with the big electrification scheme in India.

Railway Activities.

For 1925 the London & North Eastern Railway Company embarked on a very extensive program for the construction of new locomotives, carriages and wagons involving an expenditure of $30,000,000. Of this sum about $5,000,000 was set apart for the building of 221 locomotives for goods traffic and 74 for passenger traffic.

The popularity of the East Coast Sleeping Cars constructed on the articulated principle which reduces vibration to a minimum and ensures extraordinary comfort for the passenger, has induced the company to complete further sleeping cars of this type and these are included in a coach building program of 521 vehicles. Three entirely new trains are to be provided for the Marylebone to Manchester service, and one new train for the Marylebone to Bradford service.

There also to be nine new suburban trains. All these will be electrically lighted and as the company's own carriage building shops are already working at high pressure, about half of these are being built by private contractors. These new trains alone will eat up $5,945,000. To meet the requirements of traders, 11,700 new wagons are being provided at an estimated cost of $11,500,000. This includes 230 heavy 30-ton wagons, 1,400 covered wagons, and 4,000 coal wagons, from 12 to 20 ton capacity. Over 2,000 of these have been ordered from the wagon builders.

The renewal of running lines on the 7,000 miles of railway owned by the London & North Eastern, will account for another $6,250,000, and new bridges are being built at a cost of $1,250,000 while no less than $750,000 is devoted to the cleaning and painting of stations.

The initial part of the company's program for 1926 has just been announced and includes nearly $10,000,000 for new rolling stock. Most of the work to be undertaken will be completed in the company's own workshops, but the construction of new rolling stock in this country will also give much needed employment to the various trades supplying the necessary materials. The program includes the construction of 148 new locomotives for both passenger and goods work. Forty suburban type locomotives now operating on the London suburban services will be replaced by 63 new suburban locomotives of an improved design, the locomotives thus withdrawn being used mainly for goods shunting work in other parts of the company's system. Twenty-eight new locomotives of a 4-4-0 improved Director type are also to be constructed in order to supplement working of the Pacific locomotives, which, it is stated, are operating to advantage on the main line services of the company. Altogether $3,150,000 is to be spent on new locomotives during 1926.

The program also includes the construction of 7,400 new wagons of varying types, including covered goods, covered fish wagons and refrigerator vans for special traffics, and specially constructed 20-ton wagons for the conveyance of glass. Altogether over $6,250,000 will be spent by the L. N. E. R. in 1926 on the construction of new wagons to meet the requirements of trade.

Some Outstanding Features of the Year.

Some of the outstanding features of the year have been the introduction of various new and improved varieties of stainless and rustless steel and iron, and the launching of one vessel constructed of a new type of steel of considerably greater elasticity than usual. This vessel is now on her maiden voyage and a special letter from the inventor of the steel, F. G. Martin, metallurgist in charge of Alfred Holt & Company's laboratories (the owners of the vessel) says:

"The technical people concerned have not yet completed their investigation and it is undesirable at the moment to publish any statement about her design, etc." It is, however, currently reported that the new steel has wonderful possibilities.

The re-imposition of the McKenna duties on automobiles, has had wonderful effect upon the industry, and although huge supplies were dumped into the country up to the very day the new duties came into force, these have practically all been absorbed and the British motor trade has taken on a new lease of life. Not only is motoring greatly on the increase in the United Kingdom but the introduction of large scale mass production by certain firms has led to their exploiting foreign markets with beneficial results. As a consequence the industry is now in a far more flourishing condition than for years past, the output vastly increased—the figures by the end of the year will probably be quite double of those for 1924, and look like being immensely greater in 1926. This one industry alone must have a wonderful effect upon the demand for steel.

The housing shortage, and the decision of the Government to build a large number of steel houses, is also a factor that will make itself felt for a long time to come, since the housing program is only just beginning to make itself thoroughly felt, and the shortage remains exceedingly acute.

Another industry rapidly coming to the fore in England, in which steel plays the all important part is the manufacture of safety razor blades. Sheffield firms are making a bold bid for world supremacy in their manufacture. There is no patent preventing their manufacture, although, of course, there is a patent in the steel. Owing to the superior quality of the material which they employ these Yorkshire firms are producing magnificent blades—they have a sharp, soft touch, and rob shaving even in this severe weather, of all its terrors. So great is the public demand at home, and from users in all parts of the world, for the blades that more than a score of firms in Sheffield have taken up their manufacture, and sales are increasing every week. Quite the foremost enterprise of this kind is at Tinsley, Sheffield, where on a ten acre site containing one of the biggest single engineering shops of its description in the world (formerly used for motor-car and motor-lorry construction), Darwin & Milner, Ltd., are producing, on mass output principles, a quarter of a million safety razor blades per day from rustless high-speed steel, for which super cutting qualities are claimed. Seven hundred machines, built on the premises, are being used in the transformation within these works of the raw material to the finished article. Ultimately over 1,000 machines, all constructed by British engineers, will give a production capacity of 1,000,000 blades per day. A feature of special interest is the character of the material that is exclusively used. Unlike the carbon steel from which razor blades are universally produced elsewhere, it is a tungstenless high-speed metal of a class that hitherto has been confined to the purposes of engineering construction. Its established value from an engineering standpoint may be guaged from the fact that at present over 600,000 valves are functioning in London omnibuses, made from it. A representative of the firm and a group of allied steelworks operating in Sheffield, stated that, despite import duties, it will eventually be possible to command the American blade market. The manufacture of these safety razor blades, it is believed, only marks the beginning of a program for employing the same rustless patent cobalt high speed steel in fine cutting implements in general, such as pocket knives and table cutlery, thus bringing it into general domestic use. Hitherto, its use has been confined chiefly to engineering purposes.

One of the latest Sheffield reports—very different to a few months back says:

"In engineering tools there is plenty of activity. Makers of files are well employed on home and export orders. There is also a good call for twist drills. Similarly, in the trades which supply steel for engineering purposes there is an improved state of trade. Some of the makers of high class steel are working full time, and there is a constantly improved call for steel and castings and forgings for the motor car industry.

At the commencement of November, Middlesborough reported quantities of pig-iron "far from heavy" and stated that more blast furnaces were about to be blown in to meet requirements. At the end of the month the report was "steady progress continues, and with returning confidence customers are showing more inclination to buy——. An encouraging feature is the increased inclination to negotiate forward supplies. Customers are no longer reluctant to pay current rates for deliveries over periods ahead, and indeed contracts have been arranged beyond the end of the year on terms slightly higher than are obtainable for prompt business. Continued Continental competition is encountered, but prices of foreign products are hardly so attractive as they have been. The tone is generally more cheerful and hopeful than for some time past, and in some branches works are now fairly well employed, while prices all round are distinctly steadier."

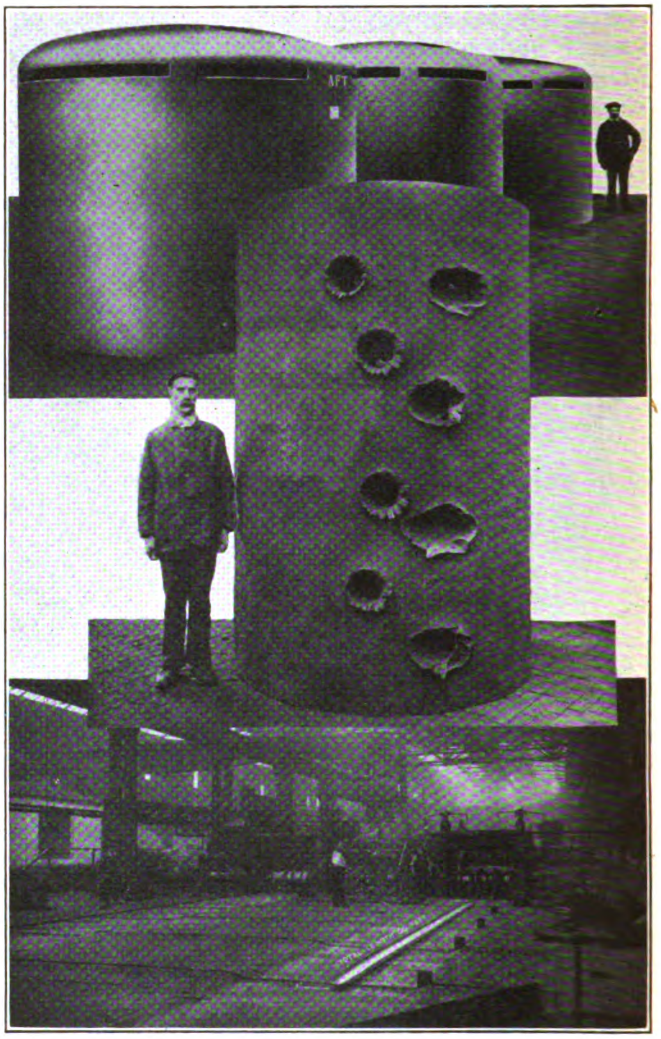

FIG. 2—*Upper views show special castings of manganese steel used in turrets and ammunition towers; lower view shows the Hadfield's, Ltd., structural mill rolling manganese steel.*

At the commencement of November only one third of the blast furnaces on the North East Coast were in operation, the number blowing being 35, eleven of which were making Cleveland pig-iron, 10 producing hematite, and fourteen manufacturing other kinds of iron. The number in blast is now considerably greater, quite a number being rekindled during the month. The Acklam Works of Dorman, Long & Company, after being closed down for 10 months, were reopened during November, another distinct sign for the better. In the Newcastle district also more fires are being lighted up and the trade tendency is steadily improving.

In order to endeavor to galvanize shipbuliding into life several suggestions have been made that the Government subsidize the industry. These suggestions have all been turned down in no measured way, and builders, as a whole, have been entirely unsympathetic towards the proposition.

Suggestions to impose duties on unfinished steel have also been thown out, but here again no encouragement has been given; in fact, as a whole, the trade is against the idea. Certain cheap Continental semi-finished steel is a very valuable adjunct to many local businesses, and without it many contracts would be lost. Sixty per cent of importations is pig iron and semi-finished products the very raw materials required by our finishing trades. To exclude these would be to seriously reduce our exports, since 70 per cent is re-exported after further manufactory. Our greatest handicap in competition with the Continent is the wage question, our rates being 40 per cent higher than the average wage paid there, although it is admitted that Continental labor is less efficient, thereby to some extent equalizing matters.

Competition in the finished article is not nearly so keen now with most of the Continental countries, owing to the more stable condition of the majority of the currencies, France being the exception. That is another reason why it is becoming more recognized that the silver lining is beginning to show itself in the cloud, while the effect of the Wembley Exhibition and the strenuous efforts to weld the Empire more closely together are commencing to bear good fruits.

Turning to the subject of "Remedy for Steel Trade Trouble" F. Scarf, managing director of the Bromford Iron Company, Ltd., says:

"The annual output per furnace in operation is as follows:

Great Britain....................	40,000 tons
France and Belgium..............	60,000 tons
America	170,000 tons

and the consumption is appreciably higher in this country. In steel making there is probably something like 10s ($2.50) per ton difference in the cost of conversion from pig iron to steel ingot as compared with the Continent. In our rolling mills the position is very similar, though it is not so easy to get at exact facts. In the conversion of ingots into steel billets and sheet bars it is possible to institute a comparison, and here it is clear that the Continental cost is little, if any, more than half our own.

"In the subsidiary operations of the trade the position is the same, and these embrace the chief improvements of recent years. We make far too little use of our blast furnace gases. Many of our furnaces are worked as independent units, and a very large amount of heat goes to waste. Most of our blast furnace gases are burnt under boilers instead of the far more economical use of large gas engines. The Staveley Company installed a large gas engine a few months ago, and the order was very naturally entrusted to Messrs. Cockerill, the Belgian ironmasters. We are only begining to recognize the necessity for cleaning these gases before use. At a discussion at Middlesborough at the beginning of this year one speaker deplores that there was only one furnace in the Middlesborough district, our premier iron-producing center, cleaning its gas, and that not by the most modern process. In 1920 examination of the subject showed that only one third of the pig-iron used for steel-making was charged hot, and there is no reason to believe that the proportion has materially altered since. As hot metal makes a difference of 4s to 8s ($1 to $2) per ton in cost, according to the proportion of scrap used, the omission to make better use of it is extraordinary.

"The cumulative effect of all these matters is enormous. It has long been known that in a modern steel plant, equipped with its own blast furnaces and coke ovens, the waste gases of the two latter will find the whole of the heat and power required. It is therefore possible to roll finished steel at a consumption of not more than two tons of coal. This is being done, or closely approached, in a few works in this country, but has been attained for more largely on the Continent. It is not possible to say with absolute accuracy what is the average consumption of coal in this country per ton of steel, but it is probably in the neighborhood of 70 cwt., or 30 cwt. more than is necessary under the best conditions."

Sir Robert Hadfield, chairman of Hadfields Ltd., in an interview with the writer, expressed hopes that the revival in trade had really set in in earnest. So far, it had not affected them very greatly, and half their huge works are still idle. They are, however, turning out their special steel for automobiles on a larger scale than ever before, and Sir Robert maintains that by their newest processes, not only are they producing the best steel for the purpose, but that they can compete with any country in the world in the matter of price. The times we have lately been passing through have given opportunities for great developments in the "Era" manganese steel, thus making it as near perfection as possible. Certainly, perfection —if ever achieved—must be somewhere near, as Sir Robert says they have "made a test of over 3,000 different steels keeping careful records of their behavior" and that offered now surpasses all others.

Edgar Allen & Company, of Sheffield, during the year have produced some most excellent new castings. They are among the large manufacturers who emphatically do not believe that Britain's day is done, and are laying themselves out whole heartedly for the imminent revival.

At the end of October the industrial relationship of the iron and steel and coal industries was brought out by Sir William Larke, who gave evidence on behalf of the National Federation of Iron and Steel manufacturers, before the Coal Commission. He said that the value of their iron and steel exports last year was £74,548,000 ($392,740,000), and this was about one half of the total product of the industry. The total number of persons engaged in the industry was 267,000, of whom 24 per cent were unemployed at the end of September. Coal was the largest single constituent in the cost of producing iron and steel in commercial forms. Last year the industry consumed 24,-5,574,000 tons of coal. Two tons of coal were required to produce one ton of pig-iron. The average consumption of coal for each ton of finished steel was approximately four tons. The industry's probable consumption of coal for this year was estimated at 22,000,000 tons. The maximum coal consumption was in 1913, when it amounted to 31,000,000 tons.

The cost of coal to the iron and steel industry was practically the same as in 1913, though for plates and heavy rails it was slightly higher, a better class of coal being used than for pig iron. In the interval some economy had been made in the use of fuel by improved practice. The cost of coal represented 40 per cent of the selling price of iron and steel products. Strenuous efforts had been made to retain markets, and Sir William said that present prices were certainly not profitable with the present volume of production.

Sir William said that the average pithead price of coal was 70 per cent above the 1913 price, but for the iron and steel industry the increase was only 40 per cent. The supply of the quantities of coal mainly used in the making of iron and steel was large in relation to demand. The competition kept the price down. Other factors which accounted for the increased cost of production of iron and steel were the costs of other raw materials, of transport, and of rates and taxes. The cost of social service had trebled since 1913. Railway rates accounted for 3s or 4s (75c to $1) of the cost of finished steel.

The cost of social services—employers' liability, health, unemployment, and workmen's compensation—worked out per ton as follows:

Sections	1s 3¼d (30½c)	3s 6¼d (84½c)
Plates	1s 6¾d (37½c)	4s 3 d ($1.06)
Rails	1s 2 d (28 c)	3s 5 d (82 c)

The average margin between the prices of British and foreign iron and steel was nearly one pound ($5), and a third of that increase was represented by charges for social services and for local rates.

There was a fall in the total demand for iron and steel. Sir William, however, expressed the opinion that there was a considerable potential demand which might be made effective, not necessarily by lowering prices, but if there were stable prices and stable conditions generally. It was correct that the restoration of the gold standard had contributed to the present depression of the industry; but that was a temporary effect. He thought that a unified control of the coal industry would be detrimental to the iron and steel industry, because it would abolish the competition in quality as well as in price.

At the recent general meeting of the United Steel Company, Ltd., the chairman, A. O. Peech, reviewed the year's operations, dealing seriatem with the results of the various works of the company and those affiliated with them. Mr. Peech, speaking on the established conditions said:

With regard to the position at the various works of the combine, in the Cumberland area the past year had been much worse than the previous year and had resulted in heavy loss. Orders have again been scarce and the works have again been obliged to operate at a low proportion of their capacity. There had been a limited demand for pig iron, which has enabled us to operate the furnaces on a reduced scale, also correspondingly the ore mines, quarries, collieries, and coking plants which supply the raw material of the blast furnaces.

In Lincolnshire our Frodingham works have again been able to operate at full capacity throughout the year with satisfactory results. The plant is one of the most economical in the country, and although the market price of the product has fallen steadily during the last 12 months substantial profits have been made.

At Appleby the original blast furnace plant has worked continuously throughout the year on a basis of two furnaces out of four, which has been sufficient to meet the demand for basic pig iron from our Sheffield works and outside customers. The works have been operated without loss, except for interest on the mortgage.

Our Yorkshire collieries and coking plants have worked during the year under increasing difficulties, and with much less satisfactory results than the previous year.

The Butlin works at Wellingborough were carried on at a loss. We have therefore, decided to shut down the blast furnace plant at these works, and in the meantime the foundry will be carried on with supplies of pig iron purchased in the local market.

Speaking generally, the past year, which, I suppose, may truthfully be described as the worst known in recent years in the heavy industries, has been one of very great care and anxiety to every section of the management at all our works, and having regard to the fact that our total output of steel during the twelve months was only about three-quarters of a million tons, I think that we may reasonably claim to have done as well as was possible in the circumstances.

Shipbuilding.

Although a considerable number of launchings of new vessels has taken place during the year, the number of new orders has been lamentably small, and right throughout the country empty berths are the order of the day. Here again, however, a more hopeful feeling has crept in during the final quarter of the year. Inquiries for new tonnage have been far more frequent and in several cases contracts for new construction have been placed, not alone for British owners, but even for Continental countries and overseas Dominions.

The outlook in the Shipbuilding and Engineering industries was recently very ably discussed by Sir Eustace H. Tennyson D'Eyncourt, K.C.B., F.R.S., the new president of the North East Institution of Engineers and Shipbuilders. The Journal of Commerce (Liverpool) says "As a shipbuilder of eminence the views of Sir Eustace on the present position and future prosperity of the industry can be accepted as authoritative and carefully considered."

Very rightly, Sir Eustace drew attention to the fact that the over-production of ships during the war years and those immediately following was largely responsible for the present trouble. Not only has this abnormal surplus of tonnage kept our shipyards empty but it has kept down freights at such a low level as to make profitable operations of tonnage extremely difficult. In the knowledge that much of the present laid-up tonnage would never again be used, Sir Eustace saw a gleam of light which the shipbuilding industry should keep before it, for at present and in the future only the most efficient and up-to-date ships could be made to pay. The present intensive study and furtherance of economy of operation of ships made the useful life of a vessel shorter now than hitherto because the ceaseless quest of economy brought along improvements in machinery more rapidly, and hence a craft became obsolete sooner under present conditions. Sir Eustace thought these changed conditions were all for the best, not only to the shipbuilder but ultimately to the shipowner as well.

The recent extraordinary improvement in ships' machinery were touched upon and the great potentialities of Sir Charles A. Parsons new higher pressure marine turbines mentioned. The latter development was spoken about as being particularly important and far reaching, as its successful and extensive application would bring the coal burning steamer into more close and equable competition with the Diesel-engined ship depending upon external supplies of costly fuel. With this view the Britisher must be in entire accord, and emphatically the majority of Britons would prefer to see our marine engineers develop the type of propelling machinery in the future that will utilize our own internal fuel resources—coal. Such a policy must be infinitely preferable to the alternative one of developing a type of ship which depends upon "outside" fuel supplies and at the same time costs very much to build in the first place—always assuming that the new type of new steam machinery can show an equal economic efficiency to the oil engine.

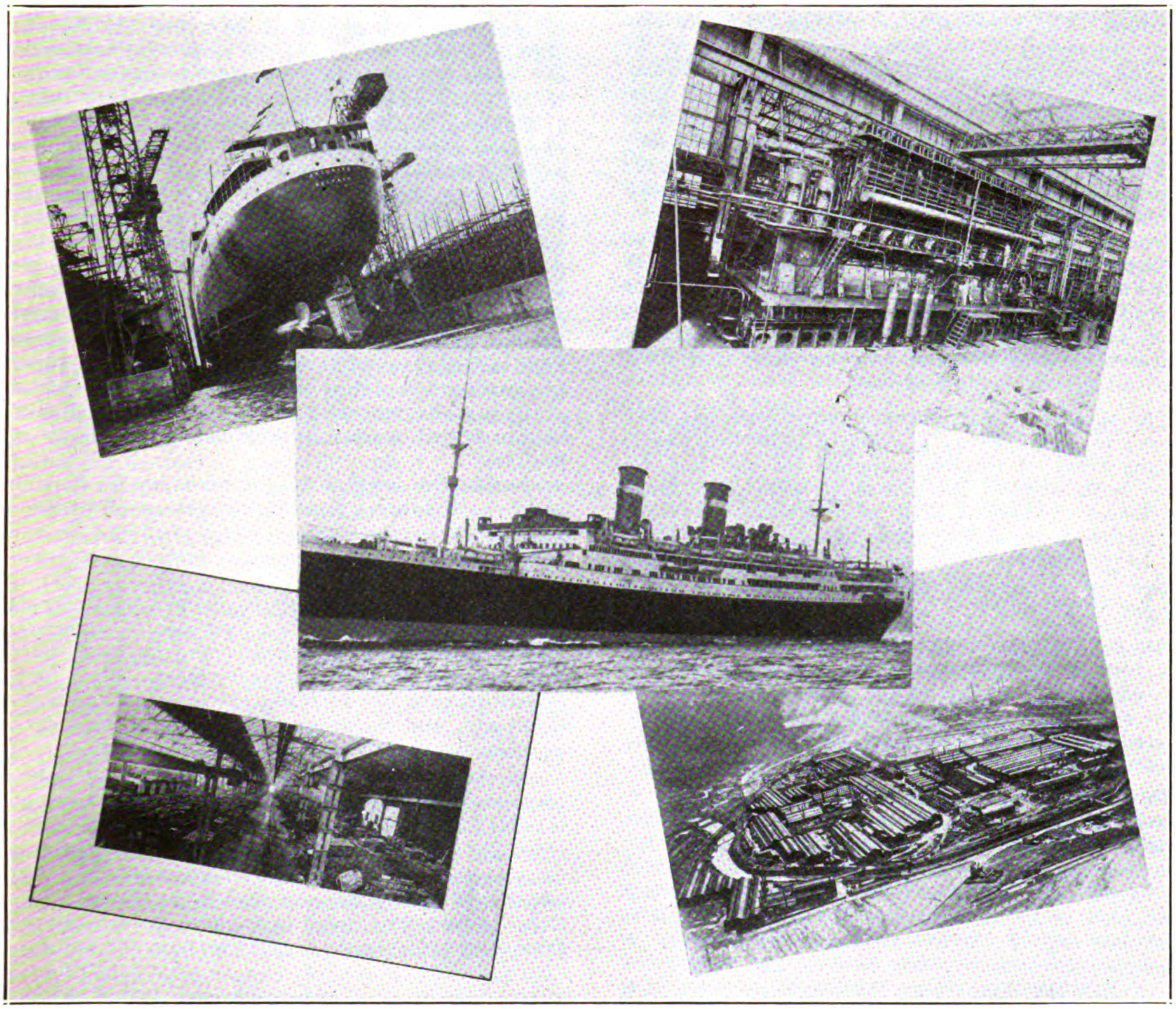

FIG. 3—*Upper left, the Asturias, a motor vessel of 22,000 gross tons built for the Royal Mail Steam Packet Co., Ltd., by Harland & Wolff, Ltd., Belfast. 10,000-hp. Diesel engine, one of a pair built by Harland & Wolff, Ltd., for the Royal Mail Steam Packet Company's Motor Liner, Asturias. Centre, The Conte Biancomano, one of the three fine liners William Beardmore & Company, Ltd., have built for the Lloyd Sabaudo Company of Genoa, for its passenger and cargo service between Italy and North and South America. Lower left, Portion of steel foundry of Edgar Allen & Company, Ltd., Sheffield Lower right, a birdseye view of the Works of Hadfields, Ltd., Sheffield, taken from an airplane. The works cover 225 acres, and the steel foundries cover over 12 acres of floor space.*

On the important question of prevailing comparative shipbuilding costs, Sir Eustace made some interesting observations. In Continental shipyards it was pointed out that repetition work was adopted more extensively than was the case in this country and longer hours were worked, often for a slightly lower rate of wages than obtained over here. The whole question of comparative shipbuilding costs has been very fully ventilated in the Press latterly, and thus the considered views of a prominent shipbuilder are of more than ordinary interest. A few extracts from Sir Eustace's address will therefore be apt.

"....the low prices which can be accepted abroad are due to the combination of a large number of factors, each of which in itself does not perhaps enable a very large percentage of reduction to be made, but which in the aggregate make it possible for the foreigner to build at 10 per cent, or perhaps 15 per cent less than we can.

(To be continued.)

Refractories for Blast Furnaces and Coke Ovens

By **M. C. BOOZE**†

REFRACTORIES play such an important role in the production of iron and steel that the subject is always an interesting one to the furnace operators. The manufacturers of fire brick are also deeply interested in the refractories problems of the iron and steel plants due to the fact that this industry consumes a large proportion of the country's total production of heat resisting materials. In spite of this we must admit that there have not been any marked developments within recent years either in the material supplied for furnace linings or in our knowledge of the service conditions under which these linings must serve. The refractories industry has been criticised from time to time for this lack of development and charged with retarding progress along the lines of more efficient metallurgical methods that would come about through the use of higher temperatures. We believe and hope to show that these criticisms are not well deserved.

The subject of blast furnace refractories has been covered in a number of previously published papers and the types of material supplied for this use, together with some of the causes of failure, are fairly well known. There is little to be gained, therefore, in a further discussion of these points. We believe it will be of interest, however, to cover the possible changes in refractories and the influence of these changes on service.

Among the more important causes for failure of a blast furnace lining are abrasion, fusion, solution by slag, disintegration due to the deposition of carbon or the condensation of metal in the pores of the brick, and reduction in refractoriness by reaction with alkalies that penetrate the lining in the form of vapor.

Fusion may take place in the melting zone or in channels along the lower inwall, due to the formation of stacks that force hot gases against the lining rather than allowing them to mingle with and lose heat to the charge. Temperatures near the tuyeres have been determined to be as high as 3,300 deg. F. This is about 100 deg. F. higher than the temperature at which the purest clay would be fluid and very much higher than the temperature at which the very best clay refractory would be rigid enough to be usable. The fire clays used in refractories are, of course, never pure and the impurities lower the softening or fusion point. The impurities are greater in amount in plastic than in flint clays and it is for the sake of refractoriness that hearth and bosh brick are made with as high a percentage of flint clay as is commercially feasible.

Since refractoriness is so necessary in hearth and bosh brick, the question naturally arises why steps have not been taken to increase the refractoriness either by the use of better clays or materials of greater heat resisting properties.

In the first place, the manufacturers are at the present time making use of clays that are the purest obtainable and that are at the same time usable without resorting to expensive manufacturing methods. By this we mean that the best flint clays that are available in sufficient quantities are selected for the purpose and that while there are other materials more refractory, they are either costly or require such treatment as would make the cost of the product high. Kaolin, bauxite, or diaspor would give higher refractoriness and are available in quantities but in each case it would be necessary to use a severe calcining treatment to prevent after shrinkage of the lining and no cheap method has been devised for such treatment. Bauxite and diaspor have the further disadvantage of high initial cost, while kaolin is not greatly superior to a good grade of flint clay. It is possible to purchase at the present time refractories made from well shrunk kaolin, but at a price approximately 6 times that of fire clay.

Purification methods are not feasible for flint clays and even if it were possible to remove all of the impurities, the refractoriness would still not be raised enough to meet the extreme operating temperatures successfully.

There are other materials of even greater refractoriness than any described, but also of higher cost, and it is probable that these could be used successfully for increasing the refractoriness. Blast furnace operators have not indicated, however, that these are necessary, and apparently are satisfied to meet the problem by the liberal use of cooling plates.

In the case of abrasion and considering only fire clay refractories, there is even less development to be expected than in the case of refractoriness.

Aside from the furnace operating conditions, kind of ore and coke used, etc., the rate of abrasion will be affected by the hardness of the refractory, the strength with which it is bonded together, and the size of the individual grains and pores. The limit in actual hardness for clays is probably closely approached by many of the products now supplied for blast furnace inwalls and tops. This is also true of bond strength, the two properties being similar and both being affected in the same way by burning. It would be possible to increase the strength as well as to reduce the size of the pores by finer grinding of inwall and top brick. No data are at hand indicating how successful such practice would be in reducing abrasion, but it is very probable that a limit would soon be reached because of the spalling troubles that would be encountered.

In those parts of the furnace where mechanical scouring action is accompanied by a temperature high enough to soften the least refractory part of the brick, abrasion would be expected to go on rapidly. However, we know very little about the rate of abrasion of refractories at various temperatures and of different structural properties. This is due to the difficulty of stimulating in a test and at high temperatures the scouring action actually met with in furnaces.

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*Presented at a meeting of the Southern Ohio Pig Iron & Coke Association, held at Ashland, Ky., November 18, 1925.

†Senior Industrial Fellow, Refractories Fellowship, Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh, Pa.

The temperatures along the middle and upper inwall are not high enough to soften the better grades of bond clays used in blast furnace refractories and here the wear resisting properties of the brick are about the same as when cold.

The condensation of alkalies in the refractory lining undoubtedly has an appreciable effect upon its life. Analyses have shown the presence of as much as 25 per cent soda and potash in brick taken from furnaces after a long campaign. The alkalies are very active as fluxes and may lower the fusion point of the brick as much as 1,200 deg. F. At certain temperatures below the ultimate fusion point they also promote vitrification and bring about shrinkage that would not otherwise take place. While a high alumina content is known to be beneficial against an alkaline slag, it would be necessary to turn to other types of material than fire clay before an appreciable effect would be obtained from this cause, as the best methods of selection would not increase the alumina content by more than a few per cent over that found in blast furnace refractories today.

The permeability to gases of fire brick is very greatly affected by the size of pores, and fortunately by making a product which is structurally suited to resist abrasion, we also have one which does not readily allow the passage of gases through it. There is a double advantage, therefore, in using a product dense and having fine pores in the inwall and top.

In some ways, it is unfortunate that flint clays are not capable of being bonded as strongly by heat as plastic clays. Their composition is such that they resist the action of most slags and fluxes to a better degree than do plastic clays. When used alone, however, they produce a comparatively soft and friable body and are not well adapted to resisting abrasion. In the hearth, where lining is in contact with a limy slag at high temperatures, the high percentage of flint clay that is used is of advantage in resisting solution.

A number of articles have been published showing the disintegrating effect of carbon monoxide on brick containing iron oxide. There are two obvious solutions for this, the first being the use of products containing a minimum of free iron oxide and the second being the use of brick that have been burned hard enough for the iron to react with the slag and form silicates.

One technical man affiliated with the steel industry has strongly advocated the weathering of clays used for blast furnace linings in order to either remove the iron or to make it visible and allow contaminated pieces to be removed. The practice of weathering is not followed for many fire clay products, but we know enough about the results obtained to be able to say that there is little benefit derived with regard to the removal of iron. In the manufacture of glass house refractories weathering of bond clays is resorted to, and even where the clays are exposed from one to two years with periodic stirring, the amount of iron taken out is hardly perceptible. It is true, however, that this procedure breaks down the coarse particles of iron bearing minerals and distributes iron oxide more uniformly throughout the mass, and if blast furnace brick were made from such clays alone, this treatment might prove to be very beneficial. However, flint clays break down very slowly when exposed to the weather and frequently not at all. They are also of a dense, impervious nature, so that there is practically no opportunity for oxidation and removal of the iron. The latter, as a rule, is found in clays of pyrite or siderite, and while pieces may frequently be found large enough to be picked out by hand, particles smaller than 1/16-in. in diameter are much more abundant. These are difficult to see and are not exposed to the weather unless the clay is first finely ground. Grinding to such fineness is not desirable even from the user's standpoint.

Attempts to remove iron by electric-magnetic and electro-static processes have not met with success. It is possible to make an appreciable reduction in the iron content in this way, but the clay must first be finely ground and a large amount of it also adheres to the iron particles and is removed at the same time.

It has been shown that when the brick are hard burned, disintegration does not take place, due either to the fact that the iron forms silicates and is no longer active as a catalyst in the formation of carbon from carbon monoxide, or to the fact that the brick are strong enough to withstand the disintegrating action. The objection has been cited that brick burned hard enough to cause the iron to react would be so brittle as to spall readily. This is not necessarily the case and even if always true, failure would probably be less rapid than when due to carbon deposition.

In discussing blast furnace refractories and the possible improvements, we have assumed in each case that the products were made in the best way and from well selected clays. This, of course, is not always true, but it is a fact that the manufacturers of fire brick as a whole are bending every effort to maintain a high standard of quality and the products are today of better quality and greater uniformity than has been the case in the past. To appreciate the truthfulness of a part of this statement, one has only to inspect the clays that are being rejected at a number of plants. The error appears in many cases to be on the side of overcautiousness.

Information given by blast furnace operators has indicated that a great extension in the life of the furnace lining could be obtained by suitably altering the furnace design or operating conditions. In answer to a questionnaire sent out by Mr. R. M. Howe*, one operator showed increasing tonnages on new linings installed in each of three furnaces. Using the tonnage obtained with the first lining in one furnace as 100 per cent, the second gave 119 per cent, the third 117 per cent, and the fourth 222 per cent. On a second furnace, and basing the tonnage obtained with the first lining at 100 per cent, the second gave 145 per cent, the third 139 per cent, and the fourth 209 per cent. These increases were obtained largely through changes in operating conditions.

Uniformity in size of refractory products has been receiving the attention of consumers within the past few years to a considerable extent and a strong demand is made for brick with extremely small variations. This is probably of greater importance for blast furnace linings than for other furnaces, due to their size, number of brick used, length of campaign, difficulty of making repairs, etc. There are a number of developments in the refractories industry that tend to make the products more uniform in size. Among these are sizing machines, tunnel kilns, and the more accurate control of such possible variables as grind, water content, etc. On account of the soft consistency when wet and greater shrinkage, hand made brick and shapes are subject to the greatest variation in size and trueness, steam-pressed or stiff mud products are next in order and dry-pressed the truest and most uniform, with other manufacturing conditions the same. Even under the most favorable conditions, however, it has not been found possible to eliminate variations to the extent that some users believe necessary. It is not at all practical, for instance, to make brick within 1/64-in. of specified thickness and yet such tolerances have been specified by consumers. Such demand, however, has had an effect on general uniformity by causing manufacturers to exercise greater supervision and so has been of some value.

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*"Blast Furnace Refractories," Trans. Am. Inst. Min. Eng., 1919, page 4.

Brick for blast furnace stoves have been the cause of much concern due to the fact that they are not called upon to meet severe conditions and since first quality material is customarily used, a long life is obtained. There is not much evidence of distress except in the combustion chamber where spalling may occur and in those parts of the checkers where a corrosive dust is deposited from the burning gases.

As regards the thermal efficiency of the checkers themselves, it has been shown* that with clay brick of the usual composition, the amount of heat taken up and given off under like conditions of heating and cooling bears a direct relation to the weight per unit volume of the brick. In other words, there is a distant advantage to be gained through the use of steam-pressed checkers over those made by hand. The difference may be as much as 6 per cent in favor of the former, this representing approximately the difference in weight between soft mud and stiff mud products. The data presented in this reference were obtained in a manner closely simulating actual conditions in regenerators and show the same rate of temperature rise and fall in both dense and open checkers. This is contrary to the opinion that has been held by a number of practical men, but the data were checked and appear to be beyond question.

Other advantages in the use of steam-pressed checkers are their high strength and resistance to slag erosion. It is true that they would spall more readily than when made by hand, but this would be objectionable only in unusual cases. Satisfactory service and high efficiency would be obtained by the use of comparatively soft burned, soft mud brick in the combustion chamber, where spalling is apt to occur, and medium burned stiff mud checkers.

By-Product Coke Oven Refractories.

Although both clay and silica brick are used in the construction of coke ovens, the latter are much greater in importance and attention will only be given to these.

The manufacture of silica brick has been described repeatedly and there is little to add to this part of the subject. We would like to point out, however, that the development of this product is distinctly an American achievement and in this line, if in no other, our refractories industry is far in advance of foreign countries. Men, interested in the manufacture of silica brick in England and Germany, who have recently visited our plants, have been amazed at the quality of our ware, the intricacy and size of shapes that are manufactured and the magnitude of the operations. These developments may have been forced through demands of open hearth and coke oven operators for materials to withstand the stress of high temperatures but credit is deserved, nevertheless.

The properties of silica brick that make them desirable for by-product coke ovens are extreme rigidity at high temperatures, good refractoriness, lack of shrinkage, good themal conductivity, and high resistance to abrasion. It is fortunate, indeed, that these properties are obtainable in a product containing very cheap and abundant raw material. The objectionable properties of silica brick are the comparatively large amount of expansion and severe spalling tendencies. These are evident in all silica products, although spalling is not apt to take place above a red heat and does not cause much concern during the regular operation of coke ovens. Soft burned brick having a high proportion of quartz present and a poorly developed bond do not spall as readily as those that are hard burned, but these are subject to a large permanent expansion when used at high temperature and this would, of course, be very detrimental in a long battery of coke ovens.

The resistance to abrasion of silica brick has been studied by Harvey and McGee*. These investigators have found that resistance varies indirectly as the porosity where the product of only one manufacturer is considered, but with silica brick in general "the ability to resist abrasion does not appear to be dependent upon any one characteristic property of the brick, but may be influenced by any one or more of the following properties: Porosity, degree of burn, grind, quality of ganister, per cent lime, and workmanship."

The high rigidity and refractoriness of silica brick are due in part at least to the absence of impurities in the rock selected for their manufacture. These properties are affected in an undesirable way by the usual fluxes and especially by the presence of an appreciable amount of alumina. This is recognized by manufacturers and probably accounts for the preference of some for talus rock from which at least part of the clay that is occasionally found in seams in the quartzite deposits has been washed out. The practice of using 2 per cent of lime for a bond in silica brick has become so general as to be almost universal. When a much greater amount is used the refractoriness is noticeably affected and a strong product is not obtained with much less.

The comparatively high thermal conductivity that is attributed to silica brick is a property of the material itself, although probably assisted materially by the relatively large and abundant pores present in these products. This is not as important, however, as would be the case if the material did not remain rigid at high temperatures and allow the use of thin walls, through which heat is transferred readily from the burning gases to the charge.

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*"The Relation of Structure and Composition to Thermal Efficiency of Refractories when used in Regenerators," by S. M. Phelps. Publication of American Refractories Institute Industrial Fellowship at Mellon Institute.

*"Factors Affecting the Resistance of Silica Brick to Abrasion," J. Am. Ceram. Soc., 7, 895 (1924).

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Electrical Application in the Steel Industry During the Year 1925

By J. D. WRIGHT*

IN the application of electric motors to main roll drives in steel mills, the year 1925 has been one of unprecedented activity. The sale by the General Electric Company alone of 72 motors totaling 141,115 hp. establishes a year's record which has never before been equalled.

The motors may be classified as follows:

	No.	Hp.
A.c. Constant speed—25 cycles	10	29,100
A.c. Constant speed—60 cycles	22	36,450
A.c. Adjustable speed—Kraemer system	2	11,100
A.c. Adjustable speed—Scherbius system	9	24,465
A.c. Changeable pole, two speed	1	800
D.c. Reversing	4	14,000
D.c. Adjustbale speed	24	25,200
Total	72	141,115

*This total hp. includes the additional horsepower resulting from the application of two double range Scherbius equipments to two induction motors installed some years ago.

This is most convincing proof that electric motors are now recognized throughout the steel industry as the standard for mill drives. Not only has their former competitor, the steam engine, ceased to be a competitor now that the economies and operating advantages obtained by the use of electric drives have become so widely known, but also steam engines on existing mills are being replaced in ever-increasing numbers by modern electrical equipment. A most notable example of this substitution of electric for steam drives is the purchase by the Colorado Fuel & Iron Company, for the electrification of its plant at Minnequa, Colo., of 12 motors totaling 19,750 hp. This electrification involved the building of a modern power plant from which two 12,500-kva. 6,600-volt 60-cycle turbine generators will supply power to the steel plant. Steam for the turbines will be obtained from six blast furnace gas and powdered coal-fired boilers at 300 lbs. pressure and 180 deg. superheat.

The Donner Steel Company put in operation a 4,000-hp. reversing motor on its 36-in. blooming mill which was formerly engine-driven. This motor derives its power from a flywheel set consisting of one 3,000-hp. 500-rpm. 2,200-volt induction motor, one 78,000-lb. steel plate flywheel and two 1,800-kw. 750-volt d.c. generators which are operated in parallel. This scheme of supplying power to a single unit reversing mill motor from two paralleled generators was first suggested by the General Electric Company in March, 1922 and since that time has been rather generally adopted.

An application of especial interest is the motor purchased by the McKinney Steel Company of Cleveland, Ohio, to drive a 10-stand Morgan continuous sheet bar mill. This is a 9,000-hp. unity power factor, 107-rpm. 6,600-volt 25-cycle synchronous motor which, from the standpoint of continuous horsepower capacity, is the largest motor of any type used for industrial purposes in the United States or, so far as can be learned, in any other country. It is also notable in that it is the first really large synchronous motor to be used for driving a rolling mill. The motor may be started, stopped, or reversed from a master switch exactly the same as any other type of rolling mill motor. The Korndorfer system of control is used and complete operation of starting on the low voltage tap of the auto transformer, switching to a higher tap, applying field at the correct time, and throwing on the line, is taken care of automatically. In the design of the motor, particular attention has been given to obtaining very good starting torque characteristics. The excitation for the motor field is derived from a separate motor-driven exciter.

The Carnegie Steel Company of Youngstown, Ohio, purchased for installation at its McDonald bar mills seven 6,600-volt 25-cycle induction motors totaling 13,825 hp. Five of these motors, totaling 8,825 hp., are provided with double range Scherbius speed regulating sets. It is interesting to note that this makes a total of 15 motors and 28,025 hp. at this one plant, which are of the adjustable speed type using the Scherbius double range system.

Another interesting Scherbius installation is that being made by the Trumbull Steel Company of Warren, Ohio. The motor is rated 5,000/4,000/3,000 hp. 450/300/275 rpm. 2,200 volts, and will be used to drive a portion of the 16-in. hot strip mill. The regulating set consists of a 1,175-rpm. synchronous motor, direct connected to two a.c. commutator type regulating machines which are electrically in series with the induction motor rotor winding. This is the first installation of a Scherbius set consisting of two a.c. commutator type machines in series, but this design permits the use of smaller and higher speed units, and the higher regulating voltage obtainable permits of designing the induction motor with a lower secondary current.

The adaptability of the Scherbius system for obtaining speed control of induction motors is furhter evidenced by the fact that the Bethlehem Steel Company has changed one of its changeable pole two-speed induction motors, purchased a number of years ago, to a 10-pole machine having approximately twice the previous horsepower capacity at synchronous speed The Scherbius speed regulating set provides speed control both above and below synchronism in a number of steps so that not only the horsepower, but also the flexibilty of the drive has been greatly increased.

This company also desired to increase the speed and horsepower of one of its motors which had been in operation for some years. This was made possible by rewinding the motor and by the addition of the Scherbius double range system, speeds above synchronism being obtained up to a maximum of 40 per cent higher than previously available. The available horsepower at top speed was approximately doubled.

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*Industrial Engineering Department, General Electric Co.

The Inland Steel Company purchased for electrification of its 8-in. continuous mill three 600-volt d.c. motors as follows: One 1,500-hp. 50/80-rpm., one 1,800-hp. 200/400-rpm. and one 800-hp. 350/750 rpm. This company will electrify its 24-in. bar mill by the installation of a 3,000-hp. 50/150-rpm. 750-volt d.c. reversing motor, and has purchased a 2,500-hp. 300-rpm. 2,200 -volt induction motor for sheet mill drive.

Electrification at the Steelton Plant of the Bethlehem Steel Company was further extended by the purchase of a 3,500-hp. 50/100-rpm 650-volt d.c. reversing motor to drive the roughing stand of its 35-in. rail mill. This motor derives its power from a flywheel set consisting of a 4,000-hp. 375-rpm. 6,600-volt induction motor, one 50,000-lb. flywheel, and one 3,000-kw generator. The 35-in rail finishing stands will be driven by a 4,000 hp. 375 rpm. induction motor which is an electrical duplicate of that driving the flywheel set.

A new tonnage record for electrically-driven blooming mills was made during the month of March at the Sparrows Point Plant of the Bethlehem Steel Company when its 40-in blooming mill rolled 90,175 tons of ingots.

A repeat order covering electrical equipment duplicating that used on this mill was placed by the Bethlehem Steel Company for a 46-in. reversing slabbing mill which will also be installed at the Sparrows Point plant. The reversing motor is a double unit d.c. motor rated 7,000 hp., 50/100 rpm. Power is derived from a flywheel set consisting of a 5,000-hp., 375-rpm., 6,600-volt induction motor, one 50-ton flywheel and two 3,000-kw., 650-volt d.c. generators.

This company will also put in operation early in 1926 a Morgan 10-stand continuous rod mill which will be driven by a 4,000-hp., 375-rpm., 6,600-volt induction motor. This mill and the wire mills for which it will supply the rods are now under construction at the Sparrows Point Plant.

The McKinney Steel Company of Cleveland, Ohio, will install five motors for driving a new 12-in. merchant mill. The roughing stands will be driven by the largest Scherbius equipment which has so far been built. The motor is rated 5,610/4,500/3,370 hp. 156/125/93.6 rpm., 6,600 volts, 25 cycles. The finishing stands are driven by adjustable speed d.c. motors, there being three 800-hp., 200/415-rpm., 600 volt machines and one 800-hp., 240/480 rpm., 600-volt motor.

The largest induction motor using the Kraemer system of speed control was purchased during the year by the Youngstown Sheet & Tube Company for a 21-in. continuous sheet bar and skelp mill, which is to be installed at its Indiana Harbor Plant. The equipment is rated 7,500/4,040 hp., 250/134 rpm.,2,200 volts, 60 cycles. Other stands of this mill will be driven by a 3,600/1,940-hp., 290/156-rpm. induction motor with Kraemer speed regulating set. The last three finishing stands are driven by three 2,000-hp., 85/165-rpm., 600-volt d.c. motors. This will be the first installation in this country of induction motors using the Kraemer system of speed control where the slip energy is not returned to the induction motor through a d.c. machine direct connected to the induction motor shaft. Instead, the equipment has been so designed that the slip energy is made available for driving the finishing motors.

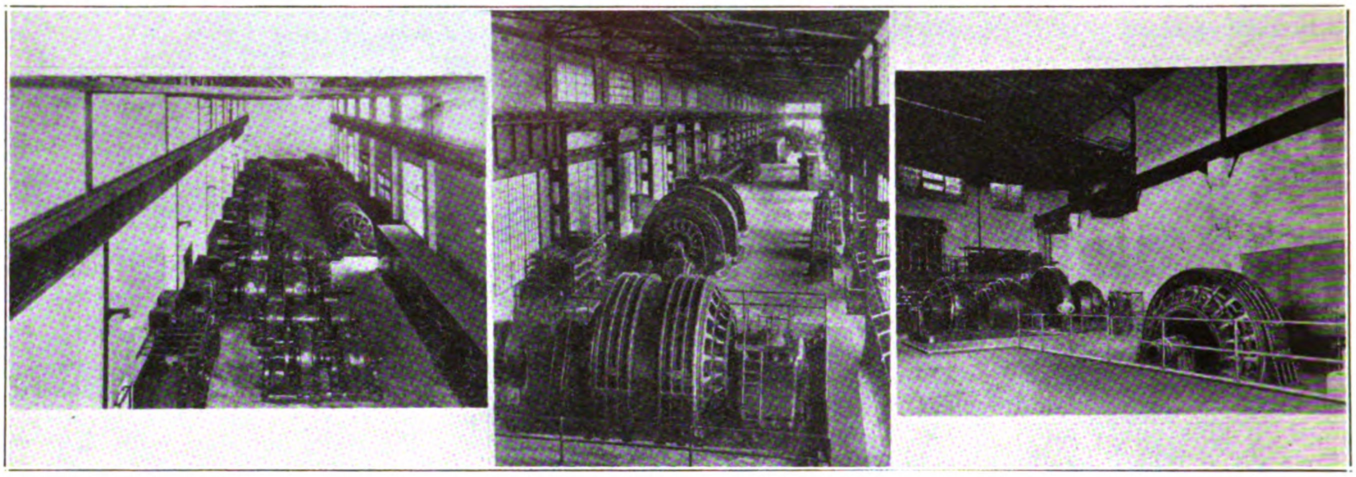

FIG. 1—*Left, 4,000-hp. motor driving 36-in. blooming mill at Donner Steel Company, Buffalo, N. Y.* FIG. 2—*Centre, 6,500-hp. motor driving Bethlehem Steel Company blooming mill at Sparrows Point. A duplicate on a 46-in. reversing slabbing mill at Sparrows Point.* FIG. 3—*New 14-in. mill at Jones & Laughlin Steel Company.*

About the first of the year the 14-in. mill of the Jones & Laughlin Steel Corporation was put in operation. This mill is one of the best examples of the present trend in the development of so-called tandem mills. The stands of this mill are so arranged that the metal is in several of them at the same time. Practically every stand is driven by an individual motor. In order to take care of the wide variety of products, a specially wide speed range of each motor was considered essential. This has been accomplished by driving the mills by means of d.c. motors which are furnished with power from several synchronous motor-generator sets; the speed range is obtained by a combination of generator voltage and motor field control.

The aggregate capacity of the several motors driving this mill amounts to 15,850 hp. (on 40 deg. C. rise basis). It will be seen from Fig. 3 that the electrical apparatus is located in the best possible surroundings; this installation points very definitely to the growing importance which the mill operators are assigning to the electrical part of their equipment.

While the cost of such an elaborate drive is relatively high, the equipment is, on the whole, very economical; the flexibility and the wide speed range permits of rolling on this mill a great variety of products which would otherwise require not less than two separate mills of a less flexible type.

Electrical Heating of Ingot Hot Tops.

Early in 1925 there was installed at the plant of the International Nickel Company, Huntington, W. Va., equipment for heating the tops of ingots, primarily monel metal and nickel. Before using this equipment, 3,800 lbs. of metal was poured to obtain a 3,000 lb. ingot, the waste averaging 20 to 30 per cent. Now 3,250 lbs. of metal is poured and 85 per cent of the ingots are used with very little cropping and a large percentage of the remaining 15 per cent is worked into commercial products.

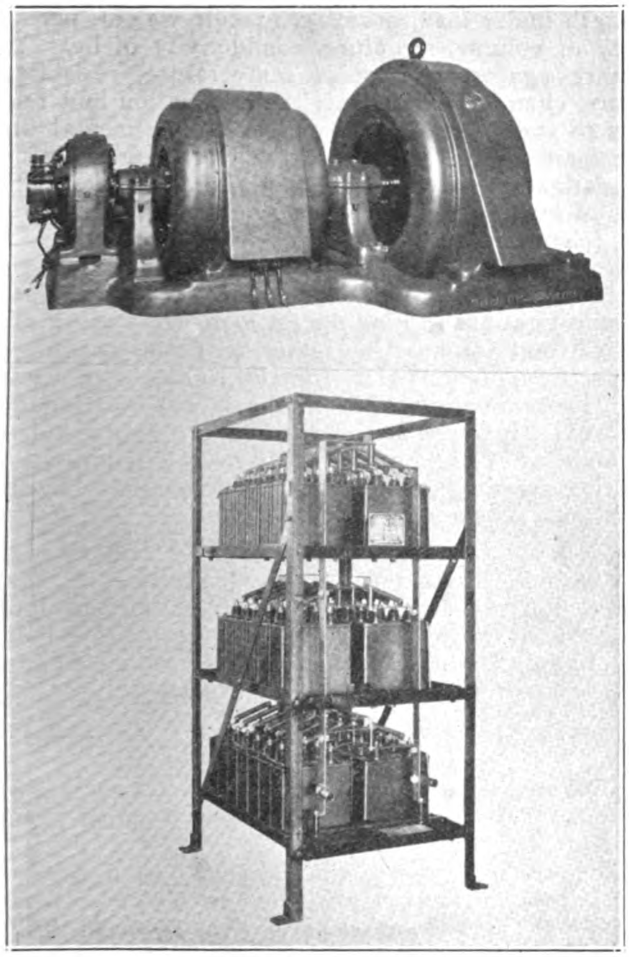

FIG. 4—*Upper, Frequency converter set for Northrup high frequency furnaces, American Brass Company, Waterbury, Conn.* FIG. 5—*Capacitor equipment for American Brass furnaces.*

The electrical equipment consists of one 1,800-kva. General Electric 3-phase transformer, designed to supply power to the ingot heating equipment and also to serve as a spare for a six-ton arc melting furnace. Other equipment consists of one 10 per cent, 3-phase, air core reactor for use in the 2,200-volt circuit, instrument and control panel, also six automatic, single phase, electrode regulator equipments for controlling the input to the arcs used to heat the top of the ingot.

This equipment has been very successful in operation and full details are given in Mr. Watson's paper delivered before the Pittsburgh Section of the A. I. & S. E. E. on December 12, 1925.

High Frequency Furnaces.

During the week of December 7, several units of the first commercial installation of Northrup Induction Furnaces operating at 480 cycles were put in operation at the plant of the American Brass Company, Waterbury, Conn. While the service in question, melting nickel silver and similar alloys, is of no special interest to the members of the A. I. & S. E. E., these equipments have many possibilities in the heating and melting of ferrous metals and alloys, several applications being under consideration at present and will undoubtedly be demonstrated during 1926.

The initial installation consists of two General Electric motor-generator sets, each delivering 600 kw., single phase, 1,875 volts, 480 cycles, to six Northrup high frequency furnaces, each generator being driven by a 3-phase, 60-cycle, 2,300-volt synchronous motor, with direct connected exciter, as shown in Fig. 4. To compensate for the low power factor and obtain best circuit conditions, a bank of capacitor units is included with each furnace, shown in Fig. 5.

Arc Furnaces.

Early in October, the equipment for the first three voltage control of arc melting furnaces was sold, for installation around the first of the year. These equipments are to be used with six-ton, three-electrode furnaces, one originally installed with a 1,200-kva. bank of transformers and the two others with a 1,500-kva. bank of transformers.

Each new equipment consists of a 2,550-kva. bank of transformers which will deliver full output at 165, 156 or 147 volts and a lower capacity at 138, 120, 95, 90, 85, 80 or 70 volts. In addition there were ordered air core reactors of 25 per cent capacity for connection in the 11,500-volt circuit, together with suitable switching equipment.

In operation the melter will have a choice of several voltages to start the heating, probably using 2,550-kva. at 165 or 156-volts, 2,400 kva. at 138-volts for the intermediate voltage and a still lower kva. at the refining voltage, probably 85 or 90 volts, depending upon the furnace requirements.

By using this equipment it is expected that considerable economics will be effected in furnace operation, especially from the standpoint of the life of the side walls and roof, together with possible reduction in electrode consumption.

In addition to the three equipments referred to above for the Halcomb Steel Company, four similar equipments have been sold, and it is expected that three-voltage operation will become the accepted method of operating arc furnaces taking 2,000-kva. and above.

Electric Roll Heaters in Demand

Freyn Engineering Company recently shipped 10 electric roll heaters to the Tennessee Coal, Iron & Railroad Company for equipment of their new hot sheet mill at Fairfield, Ala. Other recent orders for electric roll heaters include three for Reeves Manufacturing Company; three for American Rolling Mill Company; three for Pacific Sheet Steel Corporation; one for International Nickel Corporation and nine for the Kawasaki Dockyard Company, Kobe, Japan. Most of these are repeat orders.

Translation From Stahl und Eisen

By JOHANN HAHN*

No. 38—September 17, 1925

A new way for reducing the danger of break by fatigue. Herman Kändler and E. H. Schulz at Dortmund. Dependency of the attack of dissolvents on solid bodies and the form of their surface, especially at notches. Rounding of notches. Appliciation on endurance impact tests, and resultant increase in number of endurance impacts. Possibilities of practical application.

The use of oxygen, and air which is rich in oxygen at the refining process of steel. Rudolf Schenk, Münster i. W. Gas producers with air of high oxygen content. Thermo-technical and thermo-chemical meaning of an addition of oxygen at the open hearth process. Influence on the refining processes.

Steam Supply for gas producers by using cooling water from furnaces. Dipl. Ing. Rudolf Hennecke, Brandenburg, a. d. Havel. Influence, kind and quantity of steam in gas producer. Generation of steam by using the furnace cooling water in connection with a humidor. Operation and results.

No. 39—September 24, 1925

To the knowledge on Vanadium Steels. By E. Maurci, Essen. The incorrectness of Arnold's and Read's information on the Topas hardness and the A_1 point of carbon high vanadium steels. The gamma and and delta transformation of carbon free vanadium steels. The vanadium carbide V_4C_3. Physical and chemical confirmation of this formula. Explanation of the effect of a small vanadium content in the steel.

No. 40—October 1, 1925

The Modern Cleaning Room. By Professor U. Lohse, Hamburg. General information on cleaning of castings and dressing of heap sand. Cleaning grates with dust exhaust and mechanical sand conveyor. Different designs of sand blasts and cleaning tables.

Fourth Foundry Exhibition at Düsseldorf. By Carl Irresberger, Salzburg.

No. 41—October 8, 1925

Production of Different kinds of Steel in the Thomas Converter. Dipl. Ing. Erich Faust, Völkligen (Saar). Characteristic of suitable pig iron compositions for blowing of easily weldable steel, steel for pressed nuts, and rails, hard steel and steel for wire. Comparison of working processes in different plants for the above kinds of steel.

Introduction of a Form Value on Heat interchangers. Dr. Ing. H. Preussler, Gerlafingen. Quantity of heat carrier and form calculation of form value. Load co-efficient. Characteristic of the heat carrier. Meaning of heat absorption, and heat delivery. The three main cases of heat interchange: Limited but augmentable, limited but unchangeable, unlimited big. Examples. Recuperators, pusher furnaces, steam piping, heat storage and air heaters, limits of research due to limitation to transmission by conduct and contact.

Means for Favoring the Direct Reduction in the Blast Furnace. By Conrad Hofmann, Breslau. Influences, counteracting the indirect reduction. Slagging, sintering, welding, gas diffusion. Advantage of smelting fine ores. Reference to American hearth and bosh profiles.

No. 42—October 15, 1925

Research Work and Tests on Refractory Materials for Steel Works in Germany. Dr. Ing. E. H. Schulz, Dortmund. Practical importance and difficulties in testing fireproof materials. Requirements on refractories in practice. The existing kinds of investigation. Testing for analysis. Seger cone. Softening point, strength under load, porosity, specific weight, permanency of volume, structure, conductivity of heat, resistance against change in temperature, resistance against chemical influences; their valuation and relations to the demands of practice. Experimental furnace for testing fire bricks at the Dortmunder Union. Standarization of testing and of characteristics. Results of investigation on silica bricks in form of casualty (chance) curves.

Production of Different Kinds of Steel in the Thomas Converter—(conclusion of previous article).

Investigations to Find the Ratio of Areas of Air and Gas Current for an Air Heater, in Order to Obtain Proper Combustion. Dr. Ing. R. Kahlenberg, Ruhrort. Determination of a mathematical relation for the areas. Introduction of an auxiliary figure and its variability. The constant of flow. Calculation of entering areas for air and gas. The auxiliary figure. Discussion of the equation.

No. 43—October 22, 1925

Hardness Tests on Tempered Steels. R. Mailänder, Essen. Influence of hardness of the balls used. Tests with diamond ball and cold hardened steel balls. Limitations for accurate measurements. Meyers law $P = a \times d_n$ for hardened steels.

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*Pittsburgh, Pa.

Safety Chain

Sling and Crane Chain must be Safe Chain; at this particular point in operations, excuses do not prevent accidents and loss of life.

The L. G. Taylor Chain Company have stressed this important fact in their newly issued bulletin. These four pages bring out clearly the essential things to know about chains; the permissible loads, arrangement of slings, relation of angle's, types of attachments. This bulletin should be a handy reference in every Safety Engineer's file.

The National Tube Company, Pittsburgh, Pa., has work under way on the rebuilding of its No. 4 blast furnace at the National Works, and purposes to have the unit ready for blowing in at an early date; a new stove will be installed and other modernization carried out. The company will also make improvements at the local blast furnace No. 1, with the installation of four new stoves and auxiliary equipment. At its Gary, Ind., plant, an expansion program is being carried out with the installation of three new skelp mills, two of continuous type, 14-in. and 16-in., in size, respectively, and one universal mill, 42-in., with complete accessory equipment. Improvements are also being made in the blast furnaces at the Lorain, Ohio, plant of the company, with the installation of new stoves and auxiliary apparatus.

Power Progress During 1925

Several Revolutionary Developments Will Influence Future Engineering Design

By BARTON R. SHOVER*

IT is rather difficult to consider power as a study with sole reference to steel works power, or the application of power in the steel industry alone. Power has risen from the plane of an uneducated, strong limbed stoker throwing shovels of black substance into a blazing furnace of undetermined capacity, and unrecorded functions, to the dignified position of an accurate science, wherein a definite number of Btu. are expected to deliver a definite sum total of energy, and every detail of a technical science is correlated to guide the Btu. along its elusive journey from the earth's crust to the combustion chamber, through the heat exchanger and generator, the condenser, on to the prime mover or motor where we see it work.

Introducing Btu. to a wide circle of naturally disinterested and reluctant acquaintances has been a long and painstaking effort, but it can safely be said that 1926 awakens to find the Btu. as a measure of industrial wastes firmly established in the scheme of the executive elect.

In other words power has become a thing of importance.

As showing the relative importance of various fuels, and a single fuel to various industries, the following tables are interesting:

FUELS IN INDUSTRY

Manufacturers gas	2	per cent
Natural gas	4	" "
Anthracite coal	5	" "
Oil	12	" "
Coke	14	" "
Bit. coal	63	" "

OIL FUEL IN INDUSTRY

	Barrels
Steel	14,000,000
Car builders	5,000,000
Foundries	5,000,000
Sugar refining	5,000,000
Smelting and refining	5,000,000
Cement	3,000,000
Ice manufacturing	3,000,000
Paper	3,000,000
Slaughtering	3,000,000
Ship building	2,000,000
Auto	2,000,000
Copper-brass	2,000,000
Chemical	2,000,000

Viewed from any angle whatever, power in the steel industry is relatively of great importance.

There have been no changes in the tendencies shown during the preceding two years.

The prevailing application of power has become electrical. All main mill drives installed have been motor driven; the list is impressive.

Among the very notable installations may be mentioned the recently completed structural mill group at Homestead Steel Works, with its 44-in. motor-driven blooming mill, which passed the first ingot through the rolls December 28th. While these mills are not the first motor-driven mills in this great Carnegie group, the 110-in. Liberty plate mill and the 33-in. structural mill having preceded them, the construction of these large mills as the nucleus of a complete motorization program firmly establishes the future tendency throughout the corporation.

Another outstanding conversion from steam engine drive to motor drive, as a company policy, is evidenced by the Colorado Fuel & Iron's extension program. Other installations are described in this issue.

As an instance of change of power application, the turbo-blower has won its place. Economy of fuel and space together with higher blast pressures incident to heavier forcing of large blast furnace units have made the turbo-blower almost a necessity.

The 6-unit turbo-blower installation at Carrie Furnaces has performed so satisfactorily, and demonstrated such evident economies that it would be difficult to conceive of any reversion to former practice.

Steam generation continues to demand larger and more refined producing units. Edgar Thompson Steel Works have reached the millenium, or at least so it would have been considered ten years ago, by concentrating much of that great plant's steam requirements into eight 2200 (rated) double fired bent-tube type boilers. An interesting fact in connection with this installation is the arrangement developed for a variety of fuels to be burned. Primarily it is a blast furnace gas layout; four of the boilers are equipped to burn blast-furnace gas only; three more are equipped for gas, with underfeed stokers in combination; the eighth unit burns coke-braize surplus from the eleven blast furnaces at this plant on probably the largest single forced draft chain grate built.

As the prospective operation of these boilers is scheduled to average 300 per cent rating, it will be seen that approximately 40,000 bhp. can be relied on, irrespective of the fluctuations in the blast furnace gas supply, or any shortage in coke-braize.

Aggregation of a great plant's production into concentrated units of this nature, quite different than the procedure in vogue not ten years ago, when a dozen low efficiency scattered houses had to be tied together into a common header, vastly simplifies the total power problem. It now becomes practical to surround the production operation with every practical safeguard and recording device. The power-house becomes full-automatic in every sense of the word, and since it is automatic and comparative records of each of the elements of operation, the feed-water, the steam-flow, the combustion air-flow, the volume, temperature and analysis of the exit gases, the rate of fuel, are absolutely known, it follows naturally that higher efficiencies and lower unit costs must result. One tendency, too long delayed, has manifested itself. The use of surface condensers rather than jet.

One of the most serious problems in power operation in the steel industry has always been the character of the water supply. No very determined effort toward an ideal condition could be possible without resort to condensate. In spite of the fact that large central stations were operating their condensers within a mile or so, and on the same cooling water supply, surface condensers did not go into steel mill power houses. With the development of the modern surface condensers, and the installation of increasingly large steam turbines, it is reasonable to expect that the surface condenser will be the ultimate solution of the bad feed-water condition.

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*Consulting Engineer, Pittsburgh, Pa.

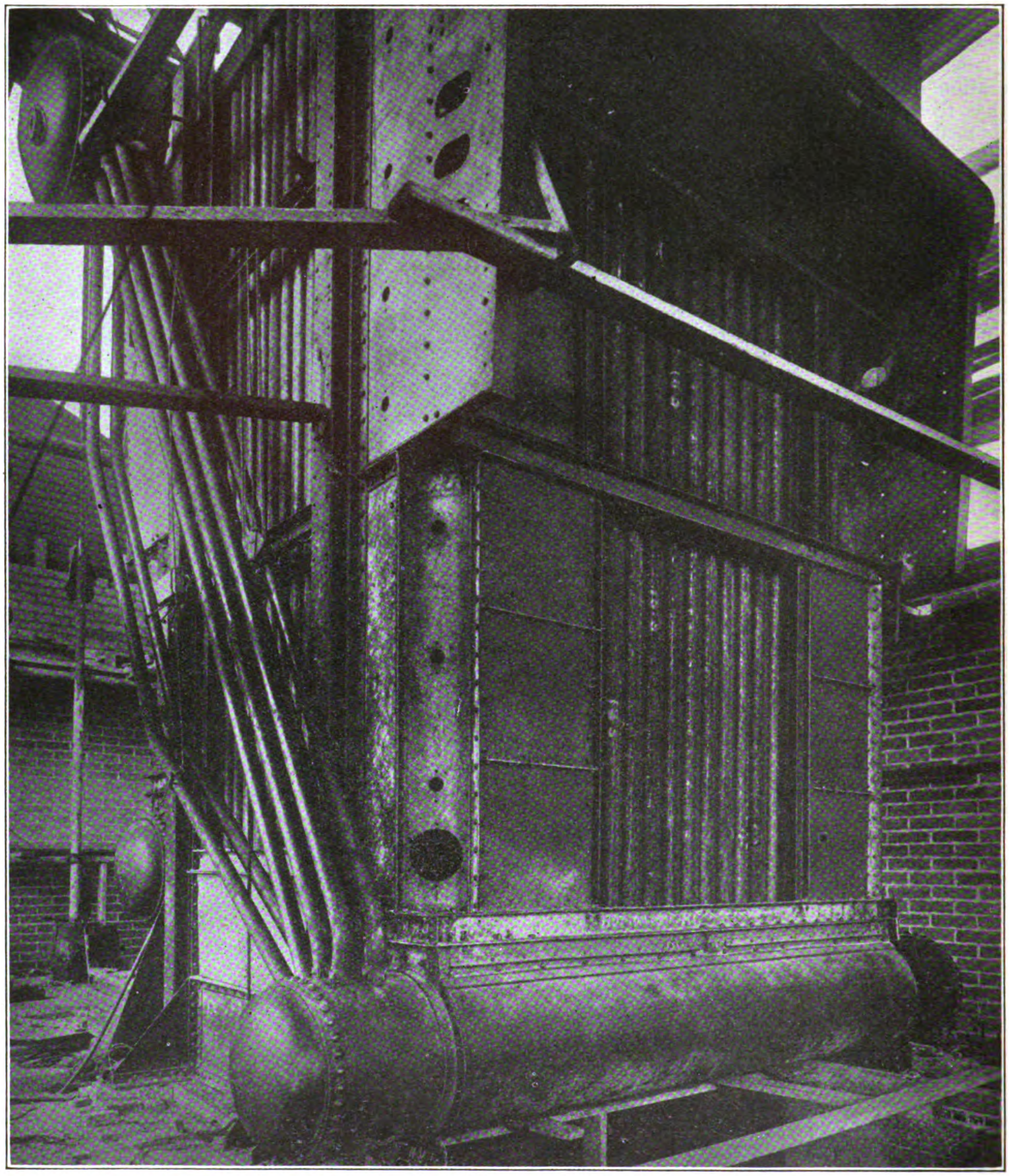

FIG. 1—*The recently announced Radiant Heat Boiler, in which the furnace, or combustion chamber is self-contained.*

Changes in detail equipments are unimportant except in the introduction of the radiant heat boiler, and the centrifugal design pulverized fuel fired furnace; both of these developments have an important bearing on future tendencies in design. The centrifugal design furnace was described and pictured in the July issue of this journal, and the radiant heat boiler in the December issue. The natural result of both these developments will be toward a reduction in the extravagant sizes toward which boiler furnaces had leaped. To assume that pulverized fuels cannot be burned successfully except in enormously over-sized combustion chambers, just because it is being so burned in a relatively few of them, is almost as erroneous as the assumption prevalent ten years ago that pulver-

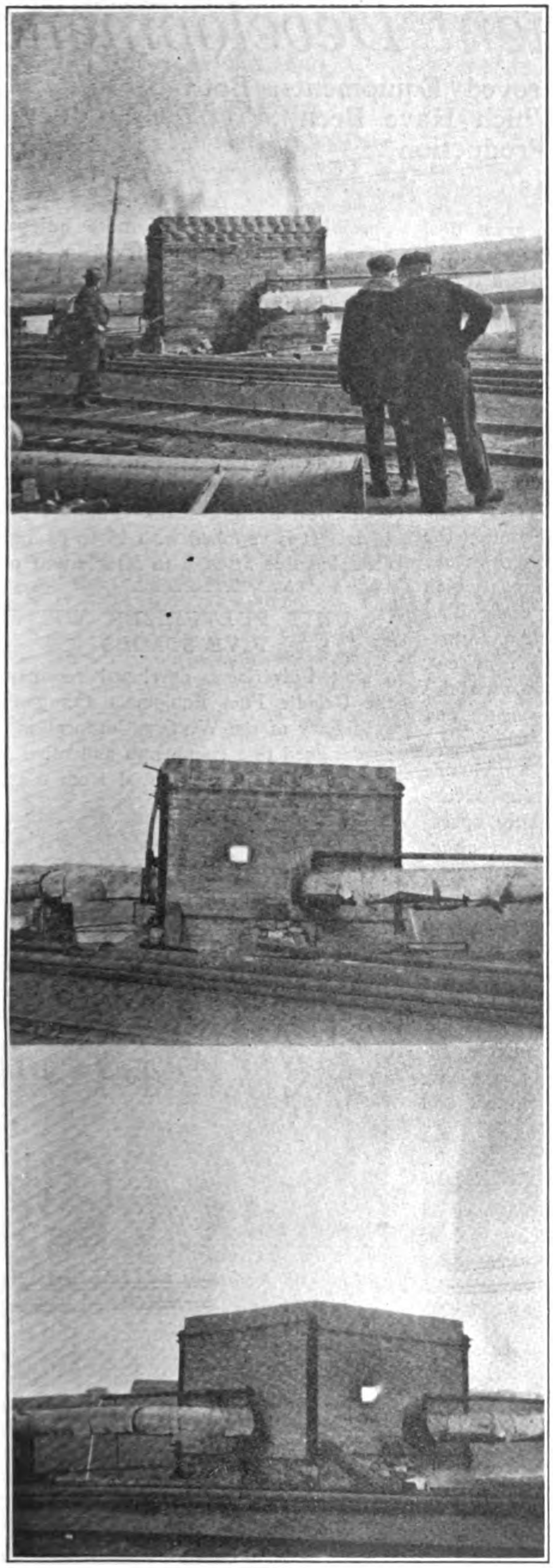

FIG. 2—*Three views of centrifugal type furnace designed to burn pulverized coal in a limited combustion chamber.*

ized fuel could not be safely and economically burned at all.

If we can take a leaf out of the experience book of the metallurgical furnace, we may find that any normal sized combustion chamber can be utilized to burn pulverized fuel safely, provided the character of the pulverized product is definitely assured.

The year 1925 found continued emphasis placed upon higher pressures, but not higher temperatures in the steam. Much excellent research was accomplished, and a number of excellent papers were delivered before the societies. Even the railroads awakened to the value of co-operative association with the engineering societies; incidentally no single section of "power operators showed greater proportionate improvements than the locomotive group."

The Weymouth Power Plant, described in May (this journal), is unique in its special application of higher pressures. A grouping of four main boilers, three operated at 350 lbs., and one operating at 1250 lbs., discharge steam into a main turbine, the 1250-lb. boiler, however, discharging into a 3,000-hp. turbine, without condenser, exhausting at 350 lbs. pressure into the main turbine system. The net improvement, which was estimated at about 10 per cent economy, has been found in practice to exceed that figure. A kw. at 14,000 Btu. is not far distant.

The steam drums of the 1250-lb. pressure boiler are special forgings made by the Midvale Company, Philadelphia, and are a wide departure from the usual steam drum as we have known them.

Continued emphasis is being laid upon improving the details of individual high pressure boilers. Greater emphasis is evident upon automatic boiler controls, and upon quality steam; the steam purifier has justified the claims made for it, until now it approaches acceptance as an integral part of every boiler.

The Radian Heat Steam Generator represents the most radical and important development that has thus far occurred in steam boiler practice. Generally speaking, there has been no substantial improvement in boiler design in many years. The present type of boiler, with minor exceptions, has not advanced since the days of James Watt. It has never been considered in rational designs either as a steam generator or as a part in the complete unit, comprising fuel burning words, for possibly 150 years the generation of steam through boilers has not advanced in keeping with the combustion process. Engineers have known that the lower row of tubes in a boiler exposed to the radiant heat of the fire and the heating surface included in the first pass, do a very large percentage of the total work, but they have found no way to apply this basic fact to the present-day type of boiler.

It is the application of this principle that has been responsible for the remarkable results obtained with the Combustion Steam Generator. In this generator practically all the boiler heating surface is exposed to radiant heat. The application of pulverized fuel firing to the generator design permits the elimination of the large furnace with its refractory surfaces, water screens, side wall screens, etc., required with all existing types of boilers.

The Steam Generator unit consists of a furnace, the walls of which are composed of tubes of the fin type, all exposed to radiant heat. Pulverized fuel is introduced through burners in the four corners and burned in a turbulent condition in the form of a vortex, due to the fact that the primary mixture of fuel

(Concluded on page 108.)

Review of 1925 Equipment Developments

Brief Descriptions of New and Improved Equipments, Both Mechanical and Electrical, Which Have Been Introduced as Aids to Production

By D. L. MATHIAS

NEW MODEL DIE SINKER

The Pratt & Whitney Company of Hartford, Conn., has recently brought out a new design of the No. 2 and No. 3 die sinkers which have been well known to the trade for a number of years. The new model machines represent a considerable improvement over the previous models, as the entire machine has been made heavier and more rigid with correspondingly greater ability to stand up under the severe service which a die sinker must meet. The increase in weight is about 30 per cent over the old model and is mainly in the column, which has been made much stiffer and heavier. The wearing surfaces on the knee slides and the two table slides have been broadened, with the result that wear has been reduced to a minimum and the accuracy of the machine increased.

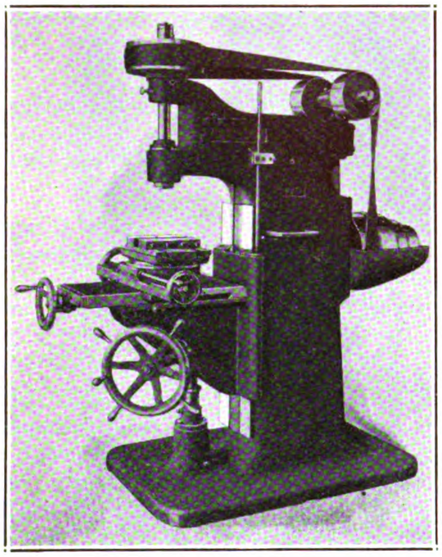
FIG. 1—Pratt & Whitney die sinker.

The drive of the new machine has been changed in that the cone pulley has been moved to a higher position in the back of the column. This new feature makes the machine easily adapted to either belt or motor drive, but at the same time retains the advantage of the smooth belt drive to the spindle. The idler pulleys carrying the spindle driving belt have been made adjustable so that the tension of the spindle driving belt can now be regulated. These pulleys have been equipped with oilless bearings.

The knee of the machine has been counterweighted in the new model so that the operation is now a great deal easier. In addition to this the elevating screw has been equipped with ball thrust washers which further increase the ease of operation. Other improvements consist of a new spindle pulley lock for the easy removal of cutters, and a wider range of spindle speeds.

In general, however, the new machines have been kept similar to the previous models which were so successful in all sorts of die sinking work. The large handwheels are kept in approximately the same locations, and the feed screws are equipped with micrometer rings which give the necessary accuracy in controlling the movement of the work. An adjustable stop insures proper depth of cut. Graduations and zero marks on all slides provide a rapid means of centering and setting the work under the cutter.

The rotary vise feed is a valuable feature which is used to great advantage in a great many die sinking operations. This rotary feed makes a circular cut easy to handle, while without it such a cut presents considerable difficulty. The spindle is equipped with lapped thrust washers, while large taper bronze boxes insure accurate alignment. The range of speeds available at the spindle has been greatly increased.

Additional equipment is available, including cutters, chucks, collets, a tilting circular vise, a cherrying attachment and cherrying cutters.

HEAVY DUTY ELECTRIC DRILL

Black & Decker have announced a very important addition to their line of portable electric tools in the form of a heavy duty ¼-in. portable electric drill.

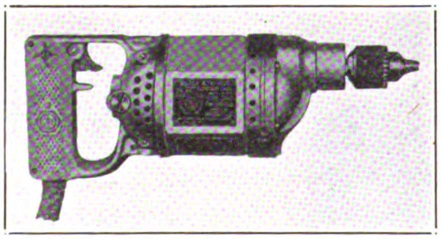
FIG. 2—Black & Decker portable drill.

The heavy duty ¼-in. portable electric drill is designed for continuous production work and for all types of maintenance work where heavy-duty performance is required. Its tremendous power, together with high spindle speed, makes possible the drilling of more holes per minute per day than any ¼-in. electric drill heretofore developed. This drill does not in any way take the place of the regular ¼-in. electric drill which has for years past won popular approval in scores of thousands of shops and manufacturing plants for maintenance work and for odd jobs of drilling.

The heavy duty ¼-in. drill is complete with heavy-duty, three-jaw geared chuck for straight shank drill bits up to ¼ in. It is supplied with 15 ft. of duplex electric cable fitted with attachment plug.

UNIT PULVERIZER WITH FIVE STAGES

Unit Pulverizers, developed recently by the Grindle Fuel Equipment Company, a subsidiary of the Whiting Corporation, are so designed that tramp iron and other foreign substances are removed from the coal which is then pulverized to a fineness suitable for furnace firing.. The feeder consists of a cast iron housing, supported independently from the pulverizer but operated through a worm and gear by means of a belt from the pulverizer shaft.

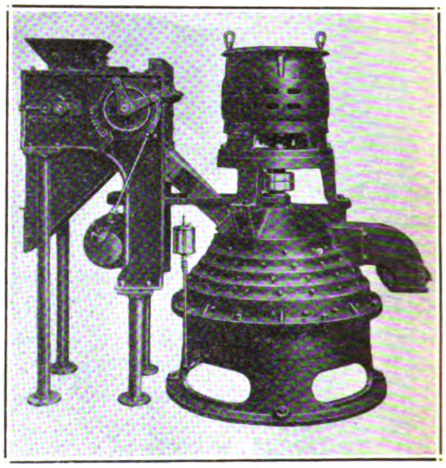
FIG. 3—Grindle unit pulverizer.

Coal is chuted to an endless belt in the feeder. This belt travels over a magnetic pulley, thus removing tramp iron and depositing it in a box which is readily accessible for cleaning. The coal passes over the magnetic pulley and through a chute from the feeder to the first of five stages in the pulverizer, which is of the vertical-shaft type. The rate of coal feed is regulated by means of a cam and ratchet device which changes the speed of the endless

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belt. The beehive housing of the pulverizer is made of cast iron and the rotor is made of cast steel. Cast-steel beater holders are pivoted to the steel-plate discs and are free to swing 90 deg. to either side. The beaters are manganese-steel castings which slip onto the beater holders. Pulverizer rings, which are bolted to the beehive housing, are corrugated and made of high-carbon, open-hearth steel. Below the pulverizing zone are fan blades for blowing the coal from the pulverizer. The entire rotor, including discs, beaters and fan blades, is fastened to a steel shaft which is direct connected through a flexible coupling to an 1,800-rpm., vertical-type motor. Gravity lubrication is obtained by means of a sight feed oil cup, which furnishes oil to the top bearing, the oil then dropping to the lower and thrust bearings. Placed opposite the top disc, to catch foreign material, such as iron pyrites, stones, wood and brass, is a cast-iron pocket. A vertical hand hole, 6 in. wide by 15 in. long, in the beehive housing, gives ready access to the beaters for replacement. A complete set of beaters can be replaced in from 15 to 20 minutes.

Operation of the pulverizer is as follows: The coal slides down the chute from the feeder and falls on the top disc of the pulverizer and is immediately thrown out against the corrugated pulverizing rings. On the rebound, the beaters strike it, pulverizing it fine enough to pass down to the next stage, and so on until it reaches the discharge chamber. The clearance between beaters and rings is such as to give proper pulverizing action and yet eliminate wear on the pulverizing parts when the machine runs empty.

The pulverizer itself furnishes air at high pressures and low volumes, making it possible to blow the coal through small diameter pipes to the furnace, where additional air for combustion can be supplied. The pulverizer can be equipped with an exhauster fan wheel of sufficient capacity to furnish all the air necessary for combustion. In most cases a separate supply of combustion air is deemed more practical.

QUICK LOADING SAND BLAST BARREL

It has long been recognized that as sand blasting is the most effective method of thoroughly cleaning metal surfaces, so too is the mass method of cleaning by the sand blast barrel the most economical, for work adapted to this character of handling. Briefly this consists of a revolving drum that holds the pieces, into which nozzles are introduced that discharge the sand blast stream against the work as the drum is rotated.

Barrels are made in drum sizes as small as 24 in. in diameter and 16 in. wide for small work and small quantities, and up to approximately 50 in. in diameter and 40 in. wide, or even larger, although this approximates the largest size for general run of work.

The cleaning time is governed by several factors. The character of the work itself; hardness and tenacity of the scale; method of sand blast application; number and size of nozzles, and the pressure maintained. This actual cleaning time varies from 10 to 45 minutes for various classes of work, although under certain conditions it may take much longer. The average forging and heat-treated pieces will require from 20 to 40 minutes, or say an average of a half hour.

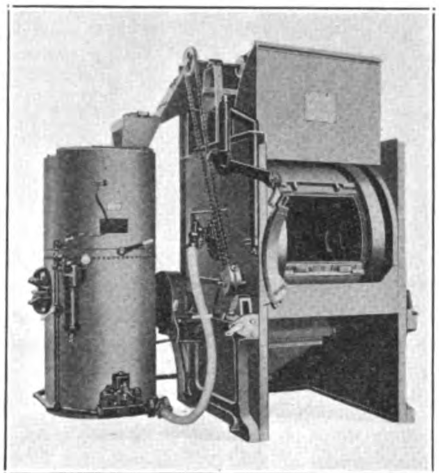


FIG. 4—Pangborn quick loading sand blast barrel.

As each load of the larger barrels, used where quantity production is required, will carry from 1,500 to 2,500 lbs. per load, this must be loaded into and unloaded from the barrel for each cleaning period. To those familiar with sand blast barrel operations it is obvious that loading and unloading takes almost as much time as the actual sand blasting of the work. This has meant that the barrel was frequently idle half of the time, and that its production was therefore only 50 per cent efficient.

Realizing the demand for large and rapid production methods, the Pangborn Corporation of Hagerstown, Md., has devised means to meet individual requirements to reduce this idle time. A new direct pressure barrel, called the "Loads-Quick," designed to quickly load and unload the work, and thus turn what has heretofore been idle time into production, is the result of the demand.

A steel plate loading skip of capacity to hold a full barrel charge is raised by overhead hoist or crane, traveling on guides that direct it into the opening of the barrel drum, when a clutch is released, that discharges the load automatically. This skip loaded with a full barrel charge is raised from the floor and discharged in 30 seconds.

Clearance under the barrel drum is sufficient to receive an unloading tote that also takes a full charge, and a chute plate in the barrel drum discharges the entire load to the tote, without handling, by simply rotating the drum.

The entire operation of stopping the barrel, discharging the cleaned load, reloading with the skip, and starting the barrel, occupies less than five minutes. Thus, if under old methods loading and unloading has taken 20 minutes, or even but 15 minutes, three-quarters or two-thirds of the idle time under old methods has been turned into production, without additional labor or air requirements—a very considerable saving in production by this method.

This new barrel can be equipped with integral motor-hoist and support, but equally lends itself to loading by crane or trolley, platform, or two-floor level operation. The barrel itself has some new features that materially increase the blasting efficiency, thus reducing the cleaning time in addition to the time saved in loading and unloading. It is of the direct pressure type, and the abrasive tank has a holding capacity of 5,000 lbs. of sand, or 12,500 lbs. of steel abrasive, which permits continuous operation for cleaning the hardest work. Individual mixing chambers provide direct feed to each of the nozzles, located in either end of the barrel drum.

All operating parts of the sand blast are on the outside of the tank, above the floor level, and thus easy to get at. Should any choke of abrasive occur in the tank, it is quickly reached and dislodged by the removal of a hand crab without necessity of dismantling the mixing chamber, or disconnecting the hose line.

The necessity of the right angle of the abrasive stream to, and its distance from, the work for quickest blasting efficiency is taken into acount, and provided for by double adjustment for the nozzles. Different weights, shapes and classes of work, ride in different positions in the barrel drum, and thus correct adjustment for quickest cleaning can be obtained for any class work, impossible with fixed nozzles.

With the nozzles held on the outside of the barrel the drum is entirely unobstructed and the nozzles can be removed for inspection and changing quickly and without the use of tools.

AUTOMATIC SHUT-OFF VALVE

To comply with the increasing demand for safety appliances, Maxon Premix Burner Company, Muncie, Ind., has developed an automatic shut-off valve illustrated in Fig. 5. This valve will automatically shut off any liquid or gas in the event of failure of any electrically operated apparatus used simultaneously with it, such as motor-driven blowers or compressors furnishing air for combustion of oil or gas.

The valve is placed in the fuel line and electric connections are made between it and the motor furnishing the air for combustion. The explosion hazard created by shooting fuel in a hot furnace or even without the necessary air for combustion is great. The result too often is serious, and while plant and equipment may be covered by insurance for just such emergencies there are many losses such as lowered morale, loss of time, production, and, if fire follows, valuable records, impossible to replace at any cost.

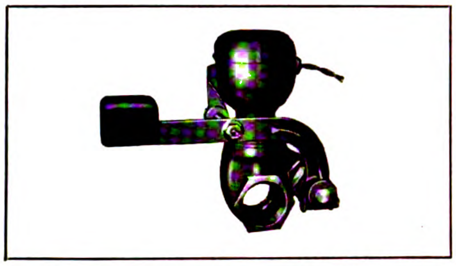


FIG. 5—Maxon automatic shut-off valve.

When the electric current supplied to the valve is interrupted, due to any cause, a magnet releases the weighted lever and the valve closes and remains closed until it is reset by hand. The valve will not hold open until electric current is again supplied.

This valve will stand hard service, due to its rugged construction. The valve proper is a Powell Petrol Throttle valve (passed by the Underwriters Laboratory). Surmounting the valve is a cast iron housing containing standard magnet, coil and latch mechanism. The lever is brass and it carries a cast iron weight sufficiently heavy to close the valve when the magnet latch releases. All parts are carefully machined and assembled.

The cost of electricity consumed by this type of automatic valve is less than one cent for 24 hours, as it uses only 10 watts an hour—cheap insurance, surely.

FUEL WASTE METER

The largest loss in any boiler plant is the heat wasted up the chimney. For measuring this important loss, the Uehling Instrument Company, of Paterson, N. J., has recently perfected a recording instrument known as the Waste Meter. With its aid, the fuel wasted may be readily determined either in dollars and cents or in Btu. or in per cent of the fuel burned during any time interval.

The Waste Meter, Fig. 1, records the temperature of the escaping flue gases and their percentage of carbon dioxide (CO_2) on the same chart. The corresponding fuel loss for any CO_2 and temperature may be read directly from a table furnished by the manufacturer. One especially important advantage of having the CO_2 and temperature recorded on the same chart is that the engineer is thus enabled to determine whether special efforts were made to increase the CO_2 during heavy firing periods, when the temperature naturally rises.

To minimize the chimney loss, it is essential to reduce the temperature of the escaping gases as much as possible, but it is even more necessary to increase CO_2 to the practical maximum percentage because the higher the CO_2, the less will be the sensible heat wasted up the chimney, regardless of the kind of fuel burned; furthermore higher CO_2, in itself, reduces the stack temperature materially, a fact that many engineers do not realize.

With the aid of the CO_2 recorder, it is comparatively easy for the fireman to control the air supply in order to keep the CO_2 fairly constant at any desired percentage. The temperature of the flue gases, however, is dependent upon the rate of driving the boiler, the cleanliness of the boiler heating surfaces and the condition of the baffles. Hence the pyrometer record shows when the soot is blown, when scale is removed from the boiler and it also shows up by-passing of the gases due to leaky or broken-down baffles.

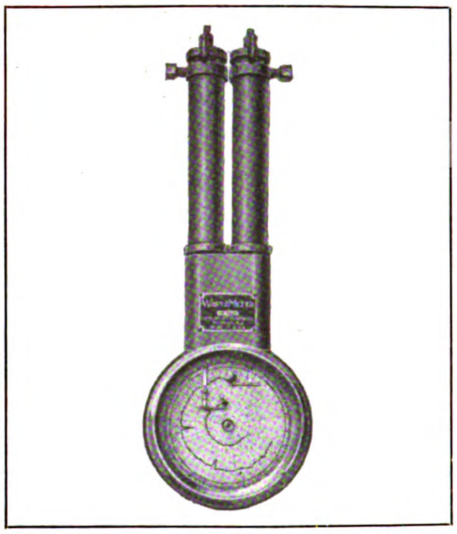


FIG. 6—Uehling fuel waste meter.

The CO_2 element of the Waste Meter operates on practically the same simple principle as the pyrometer element described below. The pyrometer element is operated by the varying quantity of air that will flow through an orifice at different temperatures. Referring to Fig. 2, air is drawn in succession through the two orifices A and B under constant suction. Orifice A is at the temperature to be measured, while orifice B is maintained at a constant temperature.

So long as the air has the same temperature in passing through A as it has in passing through B, there is no change in the partial vacuum in the enclosed space between the two orifices; if, however, the temperature of orifice A increases while that of B does not change, then orifice A will offer greater resistance to the inflowing air and in consequence the suction or vacuum between the orifices will increase.

In the application of this principle to the pyrometer, orifice A is located in a tube which is exposed to the heat to be measured, while orifice B is kept uniformly at 212 deg. F., by the exhaust steam from the aspirator of the CO_2 element. Adequate filters are provided for keeping the orifices clean permanently without attention.

Orifice A is made of platinum and is located at the end of tube 105, Fig. 2, which is protected by an outer tube 106, the inner tube 105 connecting with orifice B by copper tubing 104. "Pyro-porus" filter discs 107 and 114 clean the air perfectly without offering measurable resistance to the air flow. The air from the atmosphere is thus drawn through pet cock 109, filter 107, becomes perfectly clean, passes between the inner and outer tubes to the end of tube 105 where it acquired the temperature to be measured and then passes through orifice A at this temperature. The amount of air which enters A depends upon its temperature and this air is transmitted through tube 105 and 104 to orifice B.

Fire tube 106 is permanently located in the last pass of the boiler or wherever

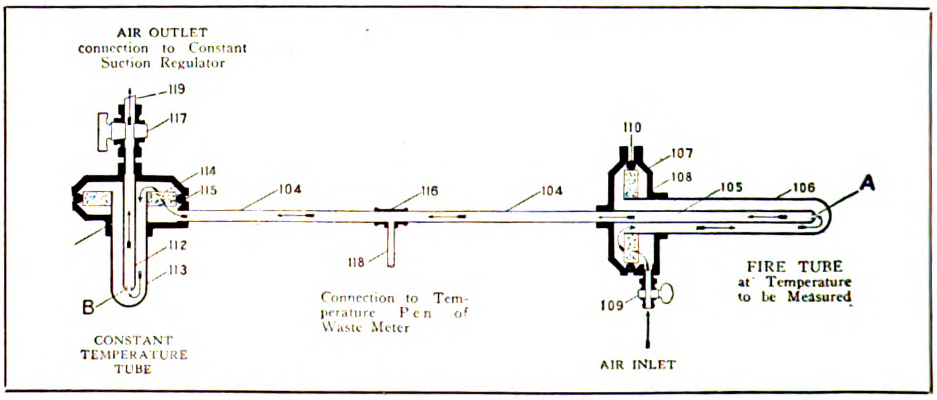

AIR OUTLET
connection to Constant Suction Regulator
119
117
114
115
104
116
104
110
107
108
105
106
A
112
113
B
118
Connection to Temperature Pen of Waste Meter
CONSTANT TEMPERATURE TUBE
109
AIR INLET
FIRE TUBE at Temperature to be Measured

FIG. 7—Sectional view Uehling fuel waste meter.

else it may be desired to record the temperature and the changing vacuum between the orifices is transmitted through tube 118 to the temperature side of the Waste Meter where it actuates a bell floating in mercury to which is attached the recording pan. The pen travel is calibrated in degrees F. for the desired range of temperature.

For actuating its CO_2 pen, the Waste Meter employs the Apex CO_2 Meter. The latter instrument is very similar to the pyrometer element, described above, excepting that its orifices are both maintained at the same temperature and the changing vacuum between the two orifices depends upon the absorption of the CO_2 constituent of the gas by means of a dry cartridge. The constant suction steam aspirator of the Apex CO_2 meter also develops the suction for the pyrometer element, while at the same time keeping orifice B of the temperature element at 212 deg. F.

The Waste Meter embodies several unique features, such as the entire absence of moving parts, rubber connections or special glassware. It employs no chemical solutions, and is self-checking for accuracy. The records are made almost instantaneously and are continuous.

AUTOMATIC SHAPE CUTTING MACHINE

In producing complicated shapes such as locomotive side rods, main rods, and other shapes, the rough shape is forged first, and the ultimate shape is formed by means of dies or machine work. The operations require power hammers, motors, furnaces for heating, several men to handle the heavy pieces, and a good man to supervise the work. Instead of using complicated and costly forging dies, an automatic oxy-acetylene cutting machine, manufactured by the Automatic Cutting Machine Company, Boston, Mass., is used in many railroad shops.

The illustration shows a machine with a cutting range of 12 ft. by 4½ ft. The machine cuts first the intricate shape on one end of the rod, then it is shifted over to cut the shape of the other end. In less than 25 min. the cutting of a large side rod is finished as if cut with a saw. The machinery consists of a light double carriage system, like a traveling crane, moving in two perpendicular planes. A tractor straddling an aluminum strip riveted to a steel plate to form a template, follows its shape automatically at a set speed. The torch, rigidly connected to the tracer, describes the same course over the billet. An aluminum template, once made, serves for 1,000 cuts or more. A side rod template takes about three hours to make and the material used is a ⅛-in. steel plate to rivet the aluminum strip on, and several feet of aluminum strip.

The machine, driven by a small motor guides and supports the torch, which, using a small oxy-acetylene flame for heating, has a jet of oxygen for the actual cutting. Six inch stock is cut at the rate of 4 to 5 linear in. per min. The machines are of the simplest construction and stand up for years without adjustments. Outside of maintenance of the cutting torch, the machine proper requires little attention.

Machine cutting of heavy pieces received a remarkable impetus ever since it had been determined how to heat-treat the pieces before and after cutting. For instance, all high carbon and alloy steels should be preheated before cutting to avoid surface cracks and fissures. All essential and driving parts should be annealed after cutting to restore the original structure at the face of the cut. This also takes out all the strains left in the billet by forging.

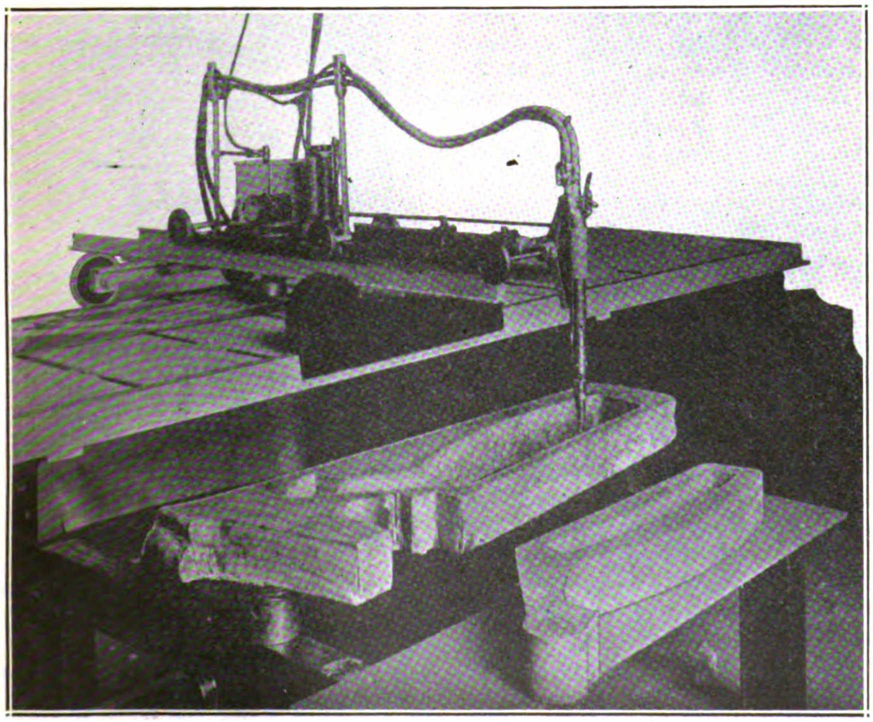


FIG. 8—Automatic shape cutting oxy-acetylene torch.

The machines can be lengthened by simply lengthening the table and the main rails. More than one cutting machine system can run on the same rails, just as a number of traveling cranes are run on the same tracks in a large machine shop.

UNIVERSAL DIE-SINKING MACHINE

The Billings & Spencer die sinking machine was developed to meet the requirements of their own die sinking department in which hundreds of thousands of dollars worth of dies are sunk yearly. The old type of machine was neither convenient nor sturdy enough to satisfactorily meet the demands put upon it in such use.

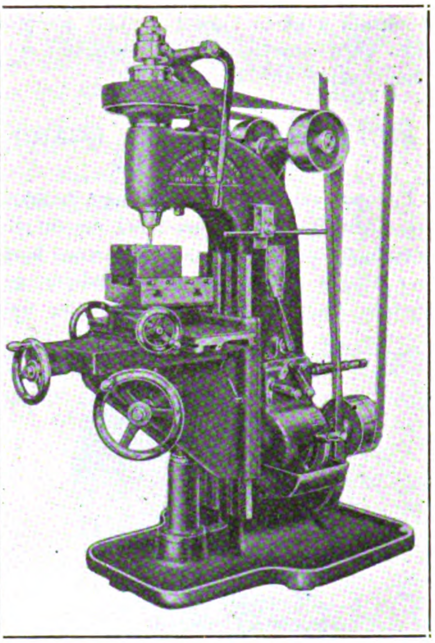


FIG. 9—Billings & Spencer die sinker.

This machine has many features new to die sinking machines. Cone pulleys have been eliminated. The machine may be driven direct from the main line of shafting through a constant speed pulley and a gear box. Sixteen cutter speeds ranging from 11 to 1,133 rpm. are regularly available. For especially light cuts, the pulleys may be changed and the machine run at a speed as great as 1,800 rpm, without harming it. A very large spindle carried on ball bearings allows heavy cuts to be taken with ease, while a flywheel attached to the spindle steadies the cut. The pulley which drives the spindle is carried on bearings separate from the spindle bearings so that the spindle bearings are not subjected to belt pull. Ball bearings are used throughout.

Another improvement over existing die sinking machines is the unique method of holding the cutters. A four jaw chuck is actuated by a handle on the side of the machine in such a way that when the handle is pulled forward the jaws are forced inward to grip the straight shank cutter. The grip is positive, and no wrenches or drifts are required. The wrench used with the old style die-sinking machine put severe strain on the spindle bearings, which is entirely eliminated by the use of this chuck, and cutters may be inserted and removed in much less time.

Further features are long, narrow guides and square locking strips on all slides, hardened and ground lead screws working in long bronze nuts tapped with Hanson taps, and a column ribbed internally both horizontally and vertically to obtain a great rigidity. The machine runs with practically no vibration even when taking the heaviest cut.

BILLINGS & SPENCER BOARD DROP HAMMER

For several years the Billings & Spencer Company has been working on the development of a heavy board drop hammer which would carry the advantages of this type of machine into the field commonly conceded to steam hammers. Early in 1925, therefore, they presented to the trade a thoroughly tested hammer in sizes from 3,000 to 6,500 pounds weight of falling ram, which had proved itself less expensive to run and capable of producing more work per day than the corresponding sizes in steam hammers.

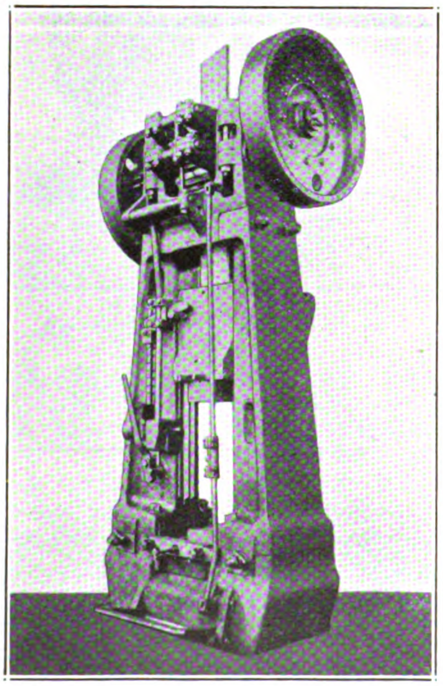


FIG. 10—Billings & Spencer Model E board drop hammer.

The chief feature of this new line of hammers is the method of raising the ram. Whereas, up to this time, board drop hammers have utilized but one pair of rolls for this purpose, these hammers have two pairs acting on the same board. One pair is placed above the other, and the two are so controlled that the pressure on the board by each pair is the same. As the allowable pressure is limited by the resistance of the board to crushing, this method increases the lifting power without increasing the pressure to a dangerous point and without increasing the width of the board beyond a practical dimension. The result is a hammer that strikes as many blows per minute as the smaller sizes of board drop hammers.

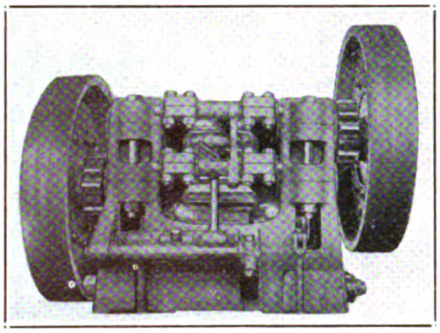


FIG. 11—Head of the Billings & Spencer four roll hammer.

Further features of these hammers are inserted guides with double V's, a straight roll releasing lever, a friction bar that is nearly straight, wedge adjustment of the uprights, a toggle mechanism on the treadle, clamps below the rolls, a sturdy and easily adjustable knock-off, a double taper to hold the shoe in the base, and a new type of multiple ring oiler to lubricate the roll spindle bearings. Moreover, the pulleys are both on rear spindles, neither of which moves during the stroke of the hammer so that the belt tension is constant.

The hammers are less expensive to run, easier and quicker to repair, less given to breakage, and are steadier producers than steam hammers.

AUTOMATIC COLD JUNCTION COMPENSATOR

The Wilson-Maeulen Automatic Cold Junction Compensator for indicating and recording pyrometers is the product of a long period of development, which included complete and thorough investigation of both mechanical and electrical means of compensation, and this electrical method has been selected for its many advantages over mechanical means.

This method of compensation is based on the actual correction of the thermocouple current, thus furnishing a correct E. M. F. to be measured by the instrument instead of creating a mechanical correction in the instrument to offset an electrical one in the thermocouple circuit.

The Cold Junction of the thermocouple is brought to the instrument by means of "extension leads" or "compensating leads", and at the point of cold junction a Wheatstone bridge is connected in the circuit.

Three of the four arms of the bridge consist of resistance which remain constant regardless of temperature variations, and the fourth arm consists of a nickel coil which varies in resistance in accordance with the changes in the cold junction temperature, and this causes the current of a dry cell to correct the thermocouple e.m.f. This electrical method of compensation has many advantages not found in any other compensation method, and at the same time avoids objectionable features. It is accurate in theory and as a commercial product. The resistance units and other parts composing it can be produced and duplicated with the greatest of precision. The resistance changes of metals in response to temperature are definite and exact.

As this device compensates directly in e.m.f. it is independent of the scale range of the instrument, and can be applied with equal accuracy to instruments of any scale range, if for the same type of thermocouple. It is entirely independent of the pyrometer instrument and external to it, and it adds no complications and imposes no weakening or undesirable changes to galvanometer design. Both double range

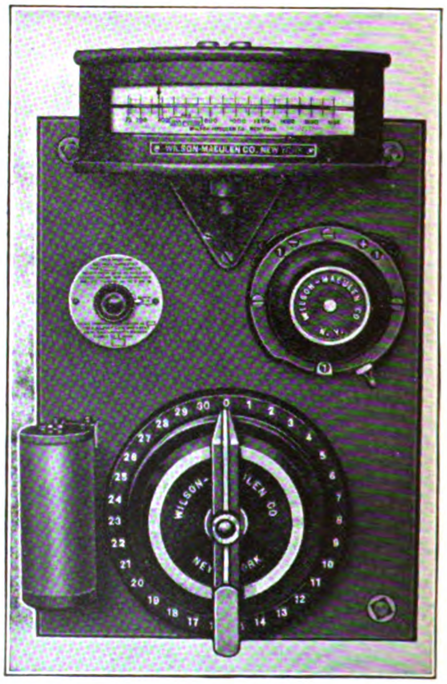


FIG. 12—Wilson-Maeulen indicating pyrometer with automatic cold junction compensator.

and single range instruments can be equipped with this compensator—the double range instrument simply requiring two compensators. No mechanical action is included in its operation, so no friction or mechanical failure can interfere with its accuracy or continued operation.

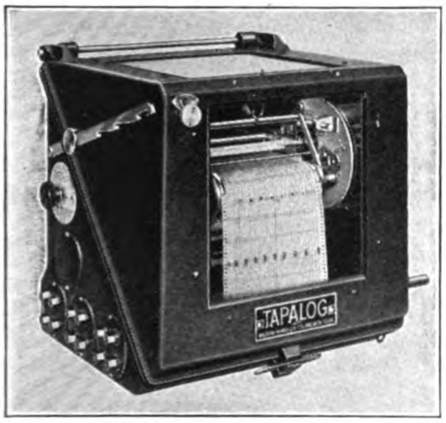


FIG. 13—Wilson-Maeulen recorder equipped with automatic cold junction compensator.

Installation is simplified, since the installing workman no longer is required to consider the theories and correct connections of buried cold junctions, etc., but instead he simply extends a pair of extension leads from each thermocouple to the instrument, and makes connections there, following very simple instructions.

ERIE FOUR ROLL BOARD HAMMER

The outstanding addition during 1925 to the line of forge shop equipment manufactured by the Erie Foundry Company, is the Erie Four Roll Board Drop Hammer. These hammers are now manufactured in sizes 4,000 lbs. and larger. At present designs are prepared for sizes up to 7,500 lbs., but it is not thought that this is the maximum size possible with this type of hammer, if there is a demand for board drop hammers of even larger sizes. The advantages of this construction may also lead to its application in the near future to board drop hammers smaller than 4,000 lbs.

The aim of this design is to reduce the unit pressure between the rolls and the board and at the same time to increase the total pressure so that the ram will be lifted more quickly, without the usual slipping between the rolls and the board. This is accomplished by using two pairs of rolls, one located above the other. The two rolls on each side of the board are carried in a pair of equalizers, which are tied together to form a rigid unit, and which are free to turn about the eccentric, so that the pressure exerted by the top roll and the bottom roll against the board must always be exactly the same. This equalization of pressure is considered an essential feature of four roll board drops, since without it, if there is a variation in the thickness of the board, or when wear occurs in the operating parts, one pair of rolls may exert all of the pressure, and the unit pressure on the board is so increased that the board is worn more rapidly than it would wear in the ordinary two roll hammer.

The eccentrics are hollow spindles, and the main drive shafts extend through the eccentrics, carried in bronze bushings. One end of the shaft carries the driving pulley, and the other end a pinion which meshes with two gears, one above and one below it, the gears being keyed to the roll shafts. The center to center distance of the gears is always the same, and therefore a standard tooth can be used, and the wear is minimized. There is a two to one reduction between the driving pinion and either of the gears, so that the rpm. of the pulleys is twice the rpm. of the rolls. By this means the belt speed is increased to an economical figure, something which cannot be done with the ordinary construction in which the pulley and the roll are keyed to the same shaft, and in which it is not feasible either to increase the pulley diameter or decrease the roll diameter.

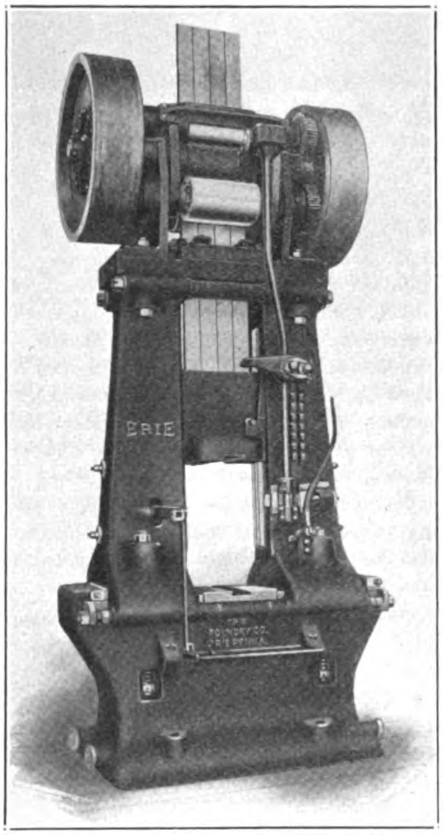


FIG. 14—Erie four roll board drop hammer.

The advantage of the equalizer design is shown by reports from shops operating hammers of this type, which state that boards have never been worn out in the hammers. It is only necessary to replace boards when they split because of the shock of the blow, and never because the rolls have worn the boards down.

Because of the increased belt speed, it is possible to use a smaller belt, and one shop, for instance, which had a 500-lb. four roll hammer working next to a 1,500-lb. two roll hammer, used exactly the same size belt on both hammers. It is noticeable too that there is no whipping of the belt of the 5,000-lb. hammer, even when striking on a heavy mass of hot steel from which there is no rebound. The cost of belt maintenance is actually less in the 5,000-lb. hammer than on the 1,500-lb.

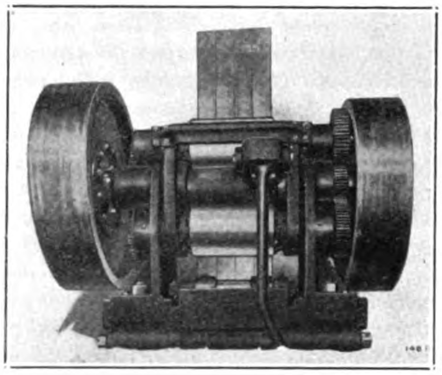


FIG. 15—Close-up view of the Erie four roll hammer.

All the four roll board drop hammers have been fitted with inserted guides which can also be furnished when specified on any size Erie board drop hammer. The bottom half of the guide is inserted and renewable, and has three Vs, while the upper half of the guide consists of a single V cast integral with the frame. The ram is lifted above the inserted section of the guide at every stroke, so that the guide can easily be removed, and with the guides out, the ram can easily be removed at working level.

TRIMMER MILLER

Realizing the need of greater speed and economy in the production of trimming and blanking dies, the Billings & Spencer Company has followed the trend of modern engineering practice in developing a special machine for this purpose. Five years of experience with this machine in their own factory have thoroughly proved that the cost of cutting blanking and trimming dies can be reduced from 20 to 50 per cent.

The machine is intended for milling out the hole in either a blanking or trimming die. It is constructed so that no part of the machine except the end of the cutter is above the face of the work, and so that the chips fall away from the piece being cut. Thus the operator's view of the lay-out lines is in no way obstructed.

The principle of the machine is simple. A table in the form of a hollow rectangle is arranged to be traversed by means of feed screws horizontally above the nose of a vertical spindle. The spindle is fitted to hold a cutter and revolve without otherwise moving.

The work is prepared for the machine by laying out on its surface the outline of the hole to be cut. On large dies, a series of close holes is drilled near the outline, and the major part of the hole broken out. On small dies, it is necessary to drill only one hole. The blank is then laid face up on the table of the machine, and fastened in place by means of binding screws which extend horizontally through parallels. The table is run to such a position that the hole cut in the piece is directly above the spindle. A cutter is dropped into the spindle chuck, and clamped in place by pulling the chuck actuating handle. The spindle is then started, and by manipulating the handwheels, the work is brought against the revolving cutter in such a way that a cut may be taken to the lay-out lines.

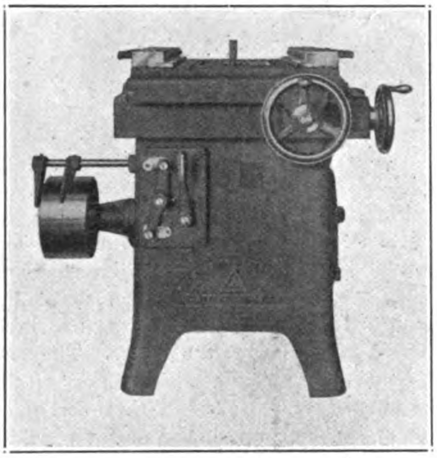


FIG. 16—Billings & Spencer miller trimmer.

The machine is so free from vibration and the table run with such evenness in all positions that a skillful operator can split this line, leaving as little as .005 inches for filing.

A straight spiral cutter may be used, or a taper spiral cutter which will cut the clearance at the same time the outline is cut may be employed. A stub cutter may next be inserted and the undercut milled without removing the piece from the machine.

The machine is built for freedom from vibration, ease of manipulation and convenience.

The box type, square column is so constructed that the spindle housing and top of the gear box are integral parts of it, fully protecting all working parts from chips. As the chips fall away from the inside of the hole being cut, openings are provided which will allow them to fall to the floor. The column casting is heavy and strong.

The table is carried on two horizontal slides at right angles to each other. Both of these slides are equipped with long, narrow, half-dovetail guides, and taper gibs, and have square locking strips at their edges. The long, narrow dovetail insures absolute freedom from jamming, while the square locking strips take the wear and strain from the dovetail. The large bearing area reduces wear to a minimum. The table works with equal ease in all positions. The taper gibs allow the table to be made tight or loose to meet the requirements of different operators.

Parallels are secured to the table top by means of keys and clamping bolts. Each parallel has eight possible positions, allowing for a range of work from 3½ to 17½ inches wide. Binding screws through these parallels provide for holding the work.

The table top is 38 in. from the floor, allowing the operator to lean over his work and easily follow the lay-out.

The spindle is driven by a constant speed pulley through change gears. Thus, the machine may be belted directly to the main line of shafting without the use of a jackshaft. The gear box gives a selection of four speeds for the spindle: 281, 421, 619 and 926 rpm. The drive is carried on ball bearings throughout.

The spindle is of extra heavy construction and is carried on heavy ball bearings. It carries the same unique type of cutter holding chuck as the spindle of the Billings universal die sinker. The chuck is so arranged that when the chuck actuating handle is pulled, four floating jaws are forced inward by the hardened and ground tapered surface of the spindle sleeve, insuring a perfect grip. The action of the chuck is positive and direct. No wrenches or drifts are required for locking or removing the cutters, so that the spindle nose and bearings are not subjected to destructive hammering.

The chuck holds straight shank cutters 1 in. in diameter. Split bushings are provided to accommodate cutters with shanks ½, ⅝ and ¾ inches in diameter.

Hand wheels, chuck actuating lever, gear shift levers, and belt shifter are all placed conveniently for the operator.

NEW RECORDING PYROMETER

The Brown Instrument Company, Philadelphia, Pa., has offered during the past year a recording pyrometer which combines the highest accuracy with a number of radically new and desirable features. It has a die cast black enameled aluminum case, the dimensions being 15 in. high, 14 in. wide and 9 in. deep, requiring a minimum amount of wall space considering the unusually wide 7-in. chart.

This instrument is built to make a single record, a duplex record with two records side by side, or in multiple form produces as many as 12 records on one chart. It operates on the frictionless principle in which a pointer swings freely and at intervals of every 30 seconds is depressed on a carbon or inked ribbon, producing a mark on the chart. This ribbon is above the paper so that the mark is produced on the front side where it shows clearly. A platen is supplied on which notes can be recorded on the chart with pen or pencil.

A glass knife edge is furnished for tearing off the paper and is located directly below the driving roll. The paper can be torn off two hours after the last impression is made.

The galvanometer and the recording chart mechanism are carried on a hinged frame. When swung aside the galvanometer is instantly accessible, and when closed a housing protects the galvanometer.

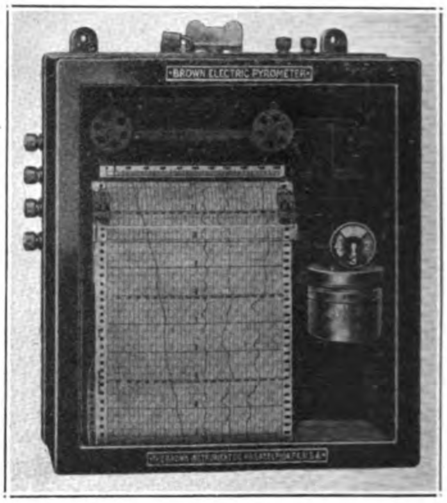


FIG. 17—Brown Instrument Co. recording pyrometer.

The recorder is driven by an electric clock if a.c. is available, but if not in use, a hand-wound clock can be supplied. The electric clock eliminated hand winding and no governor or other means is needed to secure accurate timing. The current consumed by this clock is only 4 watts.

The standard chart speed is one inch an hour, but by reversing two gears a speed of four inches per hour is obtainable. Speed combinations are available from one-quarter inch an hour to six inches an hour. With a speed of one inch per hour, about 12 hours of chart are visible through the front of the case.

The instrument as a pyrometer incorporates automatic cold junction compensation, including the Brown patented index for adjusting a compensated pyrometer to the correct initial starting point on open circuit.

As a multiple recorder, this instrument incorporates an automatic switch with gold contacts mounted on bakelite and immersed in oil, which prevents any possibility of tarnishing of the contacts from corrosive gases in the atmosphere. This switch also includes a dial with index for indicating the number of the thermocouple or furnace. The record lines are made in different colors on the chart, and the switch dial is numbered and colored to correspond.

PERCUSSION POWER PRESSES

The Zeh & Hahnemann Company, Newark, N. J., builders of percussion power presses, announces that this type of press is being successfully used for some classes of forging work. As the hydraulic forging press entered the steel works, so does now the percussion power press enter the realm of the forge shop, and does away with many of the shortcomings of the hammer or forging press.

For years these presses have been in most successful use for the production of hot pressed brass and other non-ferrous parts, and it was but one step to apply the same methods to the hot pressing of steel parts. Especially is this true since the technics of the furnace have made good progress and because of accurate heat control the material can be heated without causing much scaling.

Brass being more expensive material, the avoidance of waste was a primary consideration. But in these days of keen competition it became also an important factor for the steel forger. The field of utility of these presses lies mostly in the so-called upset forging method and it is remarkable how freely the material flows under the cumulative blow of these presses. In fact, the blow is of such a peculiar nature that it cannot be equalled by any other type of forging machinery.

The time element plays an important role. The relatively slow blow of the percussion press as compared with the hammer gives the material time to flow and fill the crevices of the dies perfectly. These presses strike the happly medium between the too slow pressure of the hydraulic press and the too fast blow of the drop hammer.

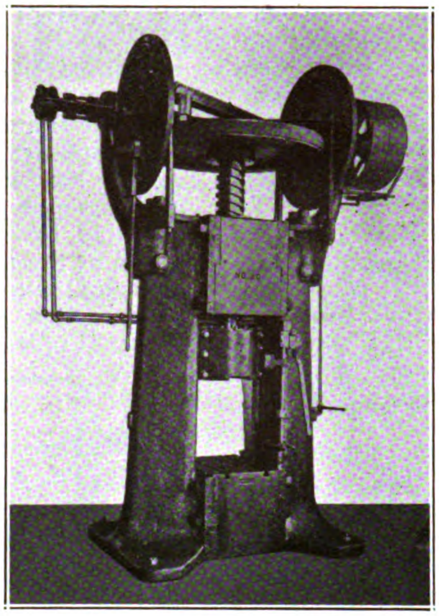


FIG. 19—Percussion power press No. 20 with 11-inch screw.

The nature of the blow may be judged by the fact that even cast iron can be forged successfully and quite a number of presses are in use to produce cast iron valve tappets. Even manganese steel has been forged successfully. The presses are also well adapted to restrike forged parts to improve the surfaces and adjust dimensions.

The slide of these presses being more accurately guided than that of hammers, more accurate work is produced. Automatic ejectors for top and bottom die can be used enabling the operator to utilize practically every stroke of the press.

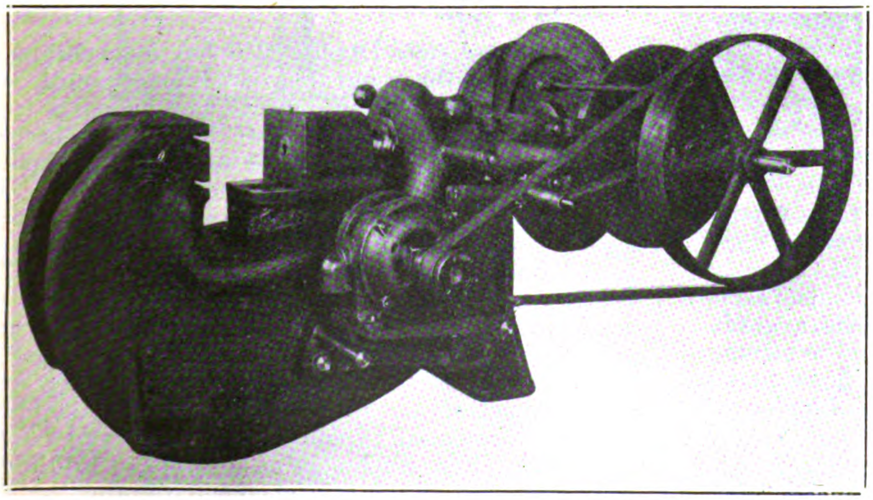


FIG. 18—Horizontally arranged percussion power press.

The presses are immune to variations in the thickness of the blanks, even if a careless operator should place a second blank on top of the other no harm will be done. The blow not being so vehement, the dies do not walk and get out of alignment. The press stops automatically at the high point of the stroke, and is securely held there. The blow can be regulated to a nicety to suit the nature of the work. The operation of the presses is very easy. Only a slight movement of the treadle is necessary.

About five hundred presses of all types and sizes are now in use; the largest size, No. 30, having a screw 16-in. diameter and yielding a blow equal to a 17,000-lb. hammer is now under construction.

ROCKWELL HARDNESS TESTER

Another development offered during the past year by the Wilson-Maeulen Company is the Model DU Rockwell Hardness Tester, which is designed for determining the Rockwell Hardness of pieces that are too heavy to use on the smaller sizes of the machine, wherein the piece being tested is elevated against the penetrating point. In this Model DU Rockwell the heavy die, or cylinder block casting, or circular saw of 5 ft. or 6 ft. in diameter is placed on the bed of the machine, (which is not generally as shown in the illustration for the base of the machine is designed individually to suit each particular class of work, though the testing mechanism mounted on the bridge which travels up and down the threaded columns is a standard arragement). The distance between the vertical threaded columns and their vertical height is also made special to suit particular requirements.

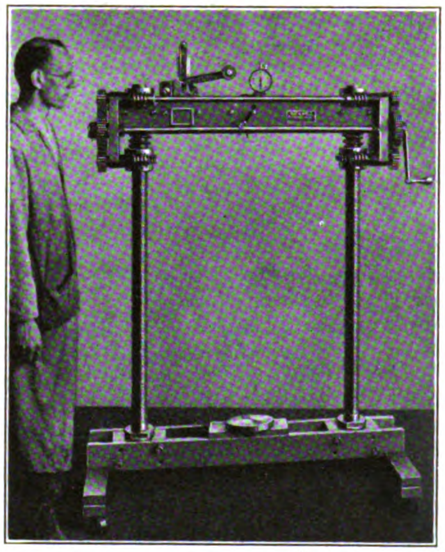


FIG. 20—Rockwell hardness tester.

TRADE NOTES AND PUBLICATIONS

Sutton-Abramsen Engineering Company have recently received orders from The Union Drawn Steel Company, Beaver Falls, for seven straightening machines. Four of these machines handle material up to 3½ in. and three of them material up to 1½ in. The same company is also in receipt of orders from Youngstown Sheet & Tube Company and Inland Steel Company, the former to be supplied with straightening machine handling material up to 10¾ in., the latter having purchased a sheet leveler.

The Link-Belt Company, of Chicago, announce the opening of a branch office in the First Wisconsin National Bank Building, Milwaukee, Wis., with Mr. R. C. Kendall in charge. This step has been taken as result of their constantly-growing volume of orders for Link-Belt Silent Chain Drives for the transmission of power.

Due to the great increase in business The Ludlum Steel Company, General Offices and Works, Watervliet, N. Y., are making many additions to their already large plant. The capacity of the billet grinding department has been doubled—the new addition to be completed and ready for occupancy early in January. This new department will be equipped with a most modern exhaust system for the elimination of the dust incidental to all grinding operations.

An industrial control catalog has been issued by the General Electric Company, bearing the number GEA-257. This publication furnishes information on representative lines of industrial control manufactured by that company and includes a reprint of the indus-control section of the company's general catalog; instructive matter on the care and operation of control devices; wiring diagrams of some standard controllers, push buttons and other accessories; reference tables; lists of publications, and other useful information. It has 160 pages, is 8-in by 10½-in. in size and is paper bound.

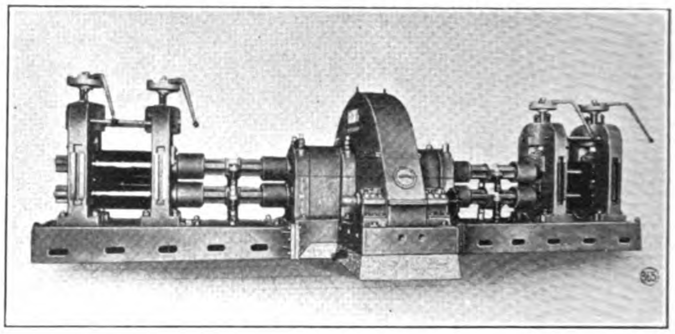
Henry Disston & Sons, Inc., of Philadelphia, manufacturers of saws, tools, and steel, announce the appointment of Mr. H. A. Baxter as manager of their steel sales department, succeeding Mr. Charles T. Evans, who has retired on account of poor health after many years as manager of the department. Mr. Baxter has been general manager of sales for the Tacony Steel Company and the Penn Seaboard Steel Corporation, of Philadelphia, for the last three years. Prior to that he was associated with the H. H. Franklin Automoble Company, the Midvale Steel Company, and the Tacony Ordnance Corporation. He is a graduate of the University of Michigan and is a member of a number of engineering and scientific societies, including the Iron and Steel Institute of London.

A convenient chart for the use of engineers who have occassion to calculate quantities connected with the expansion of steam is being distributed by the De Laval Steam Turbine Company, of Trenton, N. J. The well known Mollier diagram is printed upon a stiff sheet of Bristol board, attached to which is a scale which can be broken off and used directly for measuring heat available, spouting velocity, pounds of steam per horsepower hour and duty between given pressure limits on the entropy diagram, that is, the chart and scale give these quantities directly for a perfect heat motor. If the steam consumption of an actual engine or turbine is known, the efficiency ratio is found by a simple division. The quality of the steam at the end of a perfect expansion or at the end of actual expansion of known efficiency or steam consumption is also read off immediately from the chart. Copies will be sent upon request.

New Type Rolling Mill

The Lewis Foundry & Machine Company of Pittsburgh, Pa., will shortly issue a bulletin describing their new Duplex Mill illustrated above. This new type of mill was designed for rolling sheets and strips. Several sizes are made with both single and double reduction drives.

The advantages of this design of mill are found in the elimination of all excess friction in the drive; rigid construction to insure operation without loss of time due to breakage; minimum floor space without sacrificing accessibility in changing rolls; and economy of operation and upkeep.



The new Lewis Duplex Mill has incorporated in its design all the requisites of a modern mill, such as described on the front cover. The power is transmitted through the medium of "Lewis" cut herringbone steel gears, by a single or double reduction, and a flexible coupling between motor and drive. The drive base, with both pinion stands and main bearings cast integral, is made in one piece; and securely bolted and keyed thereto, are the mill bases. This construction insures maximum rigidity. With this arrangement the mill is always in line. The main gear cover and pinion caps are made oil tight, and all pinions are forged steel. A complete sight feed gravity oiling system not illustrated is a part of the equipment and essential to smooth operation and control of oil flow. For attachment of any type of bridling or coiling apparatus, the roll housings are provided with tee slots on both sides.

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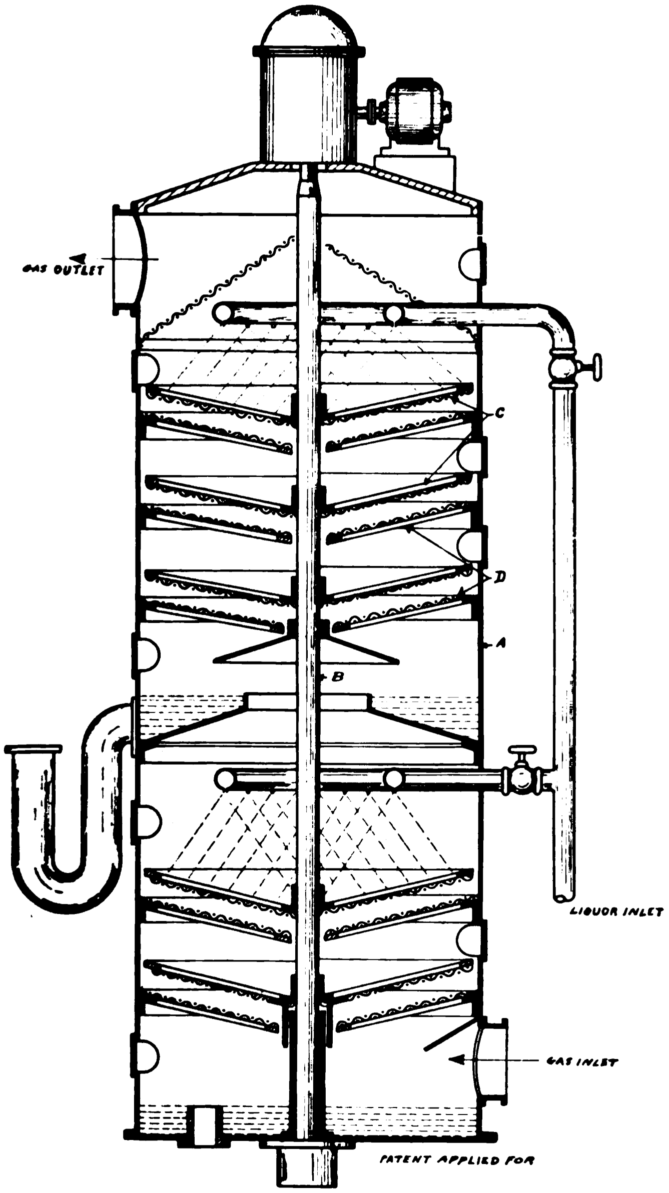
A New Gas Washer

A Mechanical Gas Washer for the Cleaning and Treatment of Blast Furnace, Coke Oven and other gases, involving advanced engineering features, will soon be placed on the market as stated by its inventor Mr. J. P. Flippen of Pittsburgh.

The Washer is illustrated by the accompanying figure reference to which will show that it consists of a vertical cylindrical shell (A), carrying a vertical shaft (B) and scrubbing grids (C and D), arranged in pairs—the number of pairs depending upon the cleaning operation, grids (C) are fastened to and revolve with the shaft, while grids (D) are stationary and fastened to the shell. One or more circular pipes fitted with spray nozzles are arranged to spray the scrubbing liquid evenly over the revolving grids, which are constructed of heavy wire mesh, which offers an extremely rough surface to the spray. It will be readily appreciated that the liquid is thus broken up into a fine mist, which is essential for efficient scrubbing. The gas entering the Washer at the bottom and leaving at the top, has to pass up through each set of grids and be subjected to an intense scrubbing action.



Most recent design of wet washer for blast furnace gas.

A novel feature of this washer is the shaft which can be raised or lowered, thereby making it possible to operate the grids as close together or as far apart as desired. It will be realized the closer together the grids operate, the greater will be the agitation of the liquid as well as the greater resistance to the flow of gas. Therefore if the gas flow should vary over wide ranges, the liquid can be proportionately varied and constant scrubbing action maintained.

The grids are operated at comparatively low speeds, this in addition to the fact that their rough surface and angle at which they are arranged prevents the liquid from being forced centrifugally to the periphery. Therefore the spray is maintained uniformly through the washer. Attention is also directed t othe absence of pockets or dead places where dust or other foreign matters may collect and build up. The most essential characteristic shown in the assembly is flexibility of operation. Should the shaft stop rotating, due to power failure or mechanical trouble, the machine still remains an efficient static washer, thus eliminating the necessity of carrying expensive spare equipment.

In addition to being a highly efficient Gas Washer, simplicity of construction is one of its major advantages. Emphasis is placed on the ease with which any part, whether stationary or revolving within the Washer can be replaced. Each grid will be made up of standard segments bolted to a spider—all of which can be removed and replaced through manholes provided between each pair of grids.

Single-Stage Centrifugal Air Compressors

The centrifugal air compressor was introduced in this country 20 years ago by the General Electric Company. It has been successfully applied to all classes of service where air is required, and also for exhausting and boosting gas. Greater flexibility, combined with lower total operating cost, including the items of power, maintenance, and fixed charges, is responsible for the standardization of centrifugal compressors for many industrial applications.

For the past three years, the General Electric Company has been conducting an intensive research program for the purpose of increasing the efficiency of the centrifugal compressor, with the result that 75 sizes have been redesigned with greatly improved efficiency. The machines are more ruggedly built and with other improvements they have been made more reliable. All parts of the unit have been made accessible and proper lubrication of the bearings is assured because of the oil pump which is supplied with all machines. This pump is driven by the main shaft of the unit.

The volume range of G-E compressors is 250 to 75,000 cu. ft. per min. The pressure obtainable with a single unit is governed largely by the manufacturing cost. The 250-cu. ft. unit can be built for pressures of from 1 to 3¼ pounds. Higher pressures are practical where the volume rating is higher; in general, the pressure range extends to 35 pounds gauge.

The listed motor-driven compressors operate at 3600 rpm. Where 25-cycle power only is available, G-E herringbone gears are employed to increase the speed. Turbine-driven units are furnished with speeds of 3,000 to 8,000 rpm.

BY-PRODUCT AND CHEMICAL NEWS

Unique Technical Sessions at Cleveland

With Chemical Equipment Exposition as a Background

C. B. MURRAY, secretary of the Ohio Section of the American Institute of Mining and Metallurgical Engineers; J. Rowland Brown, American Society of Mechanical Engineers; James H. Herron, ex-National Council member of the American Society of Mechanical Engineers, and W. H. Eisenman, National Secretary of the American Society for Steel Treating, have been appointed members of a special committee representing almost every phase of engineering and chemistry, to co-operate in preparing an unusual technical program to occur throughout the week of May 10th-15th, in conjunction with the Second Chemical Equipment, Machinery and Process Engineering Exposition of the Association of Chemical Equipment Manufacturers in Cleveland.

In addition to these three societies which, through Messrs. Murray, Brown, Herron and Eisenman, are assuming responsibility for a program unique in its representation of such a wide range of engineering interest, local sections, chapters or membership groups of the American Association of Engineers, Society of Industrial Engineers, American Society of Heating and Ventilating Engineers, American Institute of Electrical Engineers, American Society of Civil Engineers, American Chemical Society and American Electrochemical Society, are also involved.

The occasion of this inter-related and comprehensive technical program, the Association of Chemical Equipment Manufacturers' Second National Exposition, is a showing of equipment, materials, machinery and accessories basic to the application of all the chemical processes to industrial production.

It will be held in the $6,000,000 Public Hall in Cleveland and will include the latest devices, methods, operating equipment and machinery, etc., used in or adaptable to the use of absorption; precipitation and crystallization; material handling, (solids), (liquids), (gases), (flow of fluids); technology of heat, (combustion), (transfer); refrigeration; disintegration—crushing, grinding and pulverizing; mixing and agitation; mechanical separation; thickening and settling; filtration; hydraulic separation; centrifugal separation; separation—solids from gases; dissolving, leaching and extracting; evaporation; distillation; drying.

The technical program will cover a practical consideration of chemical processes, electrochemical processes, materials of construction with particular reference to ferrous and non-ferrous alloys and rubber, ceramics, mechanical design in relation to crushing and grinding, mixing, precipitation, etc.

It will reflect the inter-relation of the chemical, civil, electrical, metallurgical, heating and ventilating, welding, testing materials, mechanical and industrial engineers and of the chemist, in the application of the "processing idea" in productive industry, with the Exposition as an illustrative and connecting background.

The technical sessions will begin Monday, May 10th, and continue throughout the week. They will be held in the Hotel Hollenden, two blocks from the Public Hall. Several of the sections of national technical societies co-operating in this program have invited sister sections within a radius of 500 miles of Cleveland to participate.

A total attendance of 3,000 engineers, chemists and industrial and operating men is assured, making up what will be one of the largest directly interested groups of industrial and technical men that has ever inspected a technological equipment and machinery display.

Obituary

Mr. R. A. Storm, Manager of the Structural Department of The Morgan Engineering Company, Alliance, Ohio, died at his home on Saturday evening, January 2, 1926.

He was born in Altoona, Pa., 43 years ago.

Prior to 1901 Mr. Storm was connected with the Pittsburgh Steel Car Company in Pittsburgh, and, in 1901 he accepted a position with the Tennessee Coal, Iron & Railroad Company of Birmingham, Ala., as assistant superintendent of the Structural Department. While in Birmingham, in the year of 1910, he married Miss Johnnie Randall of that city. In the year of 1916 he accepted a position with the Morgan Engineering Company as superintendent of the Structural Department. When The Morgan Engineering Company embarked in the rebuilding of locomotives Mr. Storm was made manager of the Boiler Department, and, afterwards, manager of the Structural Department.

Mr. Storm was well known to the fabricating trade as an authority on electric arc welding of structural steel, having spoken before different organizations on this subject. His last address on electric welding was given before the American Institute of Steel Construction, at White Sulphur Springs, W. Va., November 11-14, 1925.

For several weeks Mr. Storm had a severe cold which developed into pneumonai, and was only confined to his home two weeks.

Correction

In the By-Product Coke and Gas Industry review, page 13 of the January issue, two items were misplaced. Corrected they should read:

Under construction—

Item 3. Jones & Laughlin, Hazelwood, Willputte, 60 ovens.

Item 7. Rochester Gas & Electric Co., Becker, 37 ovens.

Jones Sales Conference

The W. A. Jones Foundry & Machine Company held their annual sales conference in Chicago during the closing week of the year.

Every section of the country was represented by the group: New York, Buffalo, Pittsburgh, Cleveland, Cincinnati, Detroit, Milwaukee, St. Louis, Peoria, Birmingham prominently, so, hence the excellent group reproduction, here shown.

W. A. JONES FOUNDRY & MACHINE CO
ANNUAL SALES CONFERENCE
CHICAGO, DECEMBER 28-29-30, 1925

The value of annually getting each other's viewpoint was shown by the enthusiastic forecasts made by every member present.

Telephone Expansion

The 1926 construction program of the Long Lines Department, American Telephone & Telegraph Company, contemplates plant construction to cost more than $28,000,000. Plant costing approximately $19,000,000, was constructed in 1925.

Aerial wire, including new pole lines	$ 5,160,000
Long distance cables with associated pole lines, loading coils, building and equipment	11,200,000
Switchboards and other telephone and telegraph equipment	8,130,000
Line work not included in the aerial wire and cable projects	3,860,000

The new facilities will provide for increase in long distance telephone traffic and will also make it possible to furnish more dependable and faster service.

Long distance cable, it will be noted, is the largest single project of the construction program. The completion of the last link of the all-cable route between New York and Chicago, with cable work in other sections of the country in 1925, involved the placing of about 450 miles of long distance cable during that year. The plans for 1926 include placing more than 700 miles of this type of cable. The more important cable projects in the 1926 program are:

The completion of the Chicago-St. Louis cable which is already in service between Peoria and St. Louis.

On the New York-Buffalo-Cleveland cable project, the completion of the Schenectady-Syracuse section and major portions of the Syracuse-Rochester and Buffalo-Dunkirk sections.

The Richmond-Petersburg section of the Washington-Atlanta cable.

The Momence-Watseka, Ill., section of the Chicago-Terra Haute cable.

Additional cables on existing cable routes between Providence and Boston, New York and Philadelphia, Philadelphia and Harrisburg and Ligonier and Pittsburgh.

The 1926 construction program covers additions to the plant in nearly every state. The expenditure will amount to approximately 50 per cent more than in 1925, in which year the plant expenditures were the largest on record.

Magnitude of the Gas Industry

In 1918 there were 2,508,543 domestic and 16,581 industrial consumers of natural gas. The volume of gas consumed was 721,000,959 M. cubic feet—449,896,661 M. cubic feet of which was consumed by industries and 271,102,298 M. cubic feet was consumed by domestic consumers. The large volume of natural gas has the heat equivalent of 26,480,000 tons of bituminous coal. The total value of the gas as marketed was $153,553,650. There were required for delivery of the natural gas to the consumers more than 50,000 miles of pipe line, and 15,000,000 people living in more than 2,200 towns and cities in the 27 states were served with this commodity. The investment in the industry was more than $1,250,000,000. In order to supply this vast volume of gas it was necessary to have 40,500 producing wells drawing gas from an acreage of 14,575,457 acres with the assistance of compressing stations of an estimated brake hp. of more than 325,000. As by-products of the natural gas industry there were 282,535,550 gallons of gasoline and 43,500,000 pounds of carbon black produced.

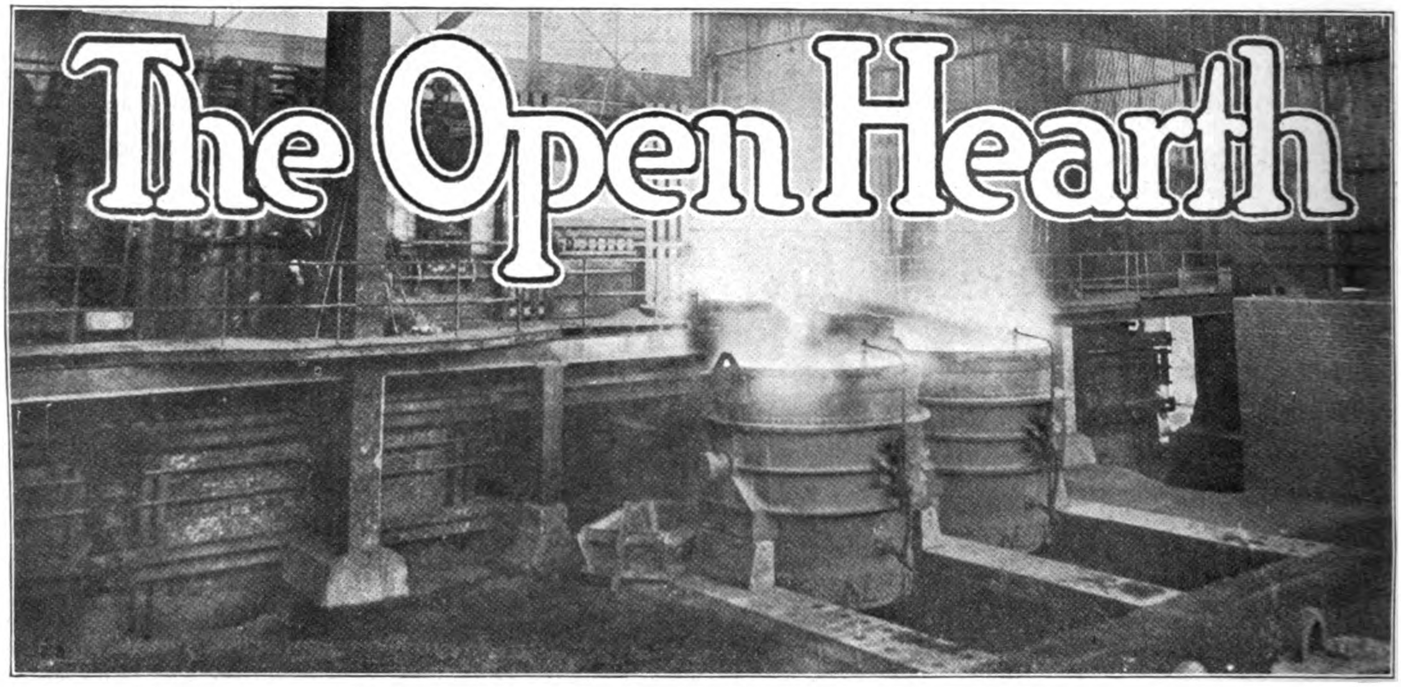
Manufactured Gas Industry.

In 1918 there were 8,124,433 consumers of manufactured gas. The volume of gas consumed was about 380,000,000 M. cubic feet. The total value of the gas was more than $450,000,000. There were required for the delivery of the gas more than 65,315 miles of pipe line. More than 48,000,000 living in 4,600 towns and cities in the 48 states were served. The investment in the industry was more than $2,750,000,000. In the making of gas in 1918 the companies used 9,000,000 tons of bituminous coal, 919,760,000 gallons of oil, 1,500,000 tons of coke and 2,000,000 tons of anthracite coal. As by-products of the manufactured gas industry there were 160,714,658 gallons of tar, 58,519,080 pounds of ammonia sulphate, 10,416,164 gallons of light oils and 545,003 pounds of naphthalene. The manufactured gas industry each day pays $200,942 in wages and salaries; spends $348,081 for all kinds of materials for gas making; buys $113,530 worth of coal; consumes $125,000 worth of oil; pays $50,000 for all kinds of taxes and rents and employs more than 65,000 people.

C. W. Hunter Becomes Vice President

Chas. W. Hunter, formerly assistant to President Paul Thompson of the U. G. I. Contracting Company, has been elected a vice president of the company.

After graduation from Cornell in 1905, Mr. Hunter became associated with the Consolidated Gas Company of New York. Later with the Peoples Gas Light & Coke Company of Chicago, and then Stone & Webster in various construction engineering capacities, he enters his present executive duties with a back-ground of unusual experience.



The Open Hearth

Charles H. Elliott, for the past year and a half superintendent of the South Side works of the Jones & Laughlin Steel Corporation, Pittsburgh, has resigned from that organization to take a leading executive and operating position with the Trumbull Steel Company, Warren, Ohio.

Alan Wood Iron & Steel Company are entering their 100th anniversary year. The announcement to their many friends takes the form of a beautiful card bearing on its face a photographic reproduction of the "Old Mill Conshohocken, Penna."

The Gulf States Steel Company, Birmingham, Ala., is pushing construction on a new bar mill at its Gadsden, Ala., plant, and expects to have the unit ready for service in February. The expansion is estimated to cost approximately $1,000,000, and will provide for large increase in capacity.

Power Progress During 1925

(Continued form page 95)

and air as well as the highly preheated secondary air enter tangentially to an imaginary circle.

The flame and gases descend through a multitubular screen into a settling chamber where the ash is deposited and the gases flow through a superheater, thence through an air preheater to the stack or to the induced draft unit.

The horizontal headers for the remaining two side walls, are as mentioned before, also connected to the lowermost drum, receiving their water supply from this drum and discharging into the upper headers which in turn are connected to the main drum.

The closing months of 1925 brought news of the mergers of several of the most important power equipment companies. The fruits of years of research have been amalgamated in formidable combinations even better qualified to carry on this costly and highly valuable effort. The net result of these associations must inevitably react to the improvement of power as a science and to the ultimate benefit of the purchaser of power and to the ultimate consumer.

The Youngstown Sheet & Tube Company has recently contracted with The Chapman-Stein Furnace Company of Mt. Vernon, Ohio, for two more recuperative ingot heating furnaces. These will be of the continuous end charge side discharge type and will be installed at the new seamless tube plant at Youngstown, Ohio.

Electric Furnace Progress in 1925

(Continued from page 71.)

ing small output of high grade metal. Fig. 3 upper right illustrates a 20-40 lb. arc furnace made by this company.

The Hoskins Manufacturing Company also continue with their line of small laboratory furnaces that have previously been described.

A new element of the non-metallic type known as Globar has been introduced by the American Resistor Company, Milwaukee, for furnace use. It is claimed that this material has a working temperature of 2,750 deg. F., 1,500 deg. C. and even to higher temperatures for a short time. This will be described and illustrated in a later article.

It is not possible in this article to describe all the smaller applications of electricity for japanning, heating soldering, etc., but mention should be made of progress that has been made in electric furnaces for vitreous enamelling. Due to faulty design of furnace, a number of these earlier furnaces were not highly successful, but the newer designs are giving extremely satisfactory results on vitreous enamelling.

Electrically heated core ovens are also coming more into general use and several large installations have also been made of electrically heated vacuum impregnating tanks in place of steam

In conclusion the writer would like to state that he does not wish it to be thought that electricity should always be applied or that it is always better than other forms of fuel. The solution of the most suitable forms of fuel should always be based on an abstract comparison of other forms of fuel, electricity has its field of usefulness as well as its limitations.

NEWS OF THE PLANTS

The Colorado Fuel & Iron Company, Denver, Colo., will proceed with the construction of a new strucural mill at its plant for the rolling of shapes up to 15 in., equipped as well for the production of rounds, squares and kindred material. The extension will cost in excess of $1,000,000, with equipment. The company is also perfecting plans for the complete electrification of the plant and will arrange an appropriation upwards of $3,500,000, for this improvement. As the initial step, work is now under way on a new power station and machinery will be installed at an early date.

The Bethlehem Steel Corporation, Bethlehem, Pa., is perfecting plans for the construction of a new tube mill at its plant at Sparrows Point, Baltimore, Md., and expects to begin work on the expansion in the near future. The unit will be designed for the production of steel tubular specialties and pipe in extensive variety, and is reported to cost more than $7,000,000, with machinery. Facilities will be provided, it is stated, for the employment of about 5,000 men. The structure will be erected in connection with a general expansion program now proposed at this works.

The Illinois Steel Company, Chicago, Ill., has arranged for the immediate erection of two new bar mills at its plant at Gary, Ind., to be equipped for an annual production of about 250,000 tons each. It is expected to push the structures to completion and have ready for service at the earliest date. The company also has work in progress on a new bar mill at its South Chicago works, which likewise will be brought to completion at an early date. The estimated cost of the expansion has not been announced.

The Pittsburgh Crucible Steel Company, Pittsburgh, Pa., has authorized an expansion and improvement program at its mills at Midland, Pa., to cost close to $2,000,000, and will begin work at an early date. The main extensions will consist of a new mill, with four furnaces and auxiliary equipment, and cindering plant. It is expected to advance the present mill capacity about 50 per cent, giving employment to 500 additional operatives. The Midland Improvement Company, an affiliated organization, is arranging for the early erection of a group of about 25 new houses for employes at the plant.

The Indiana Rolling Mill Company, Newcastle, Ind., has tentative plans under consideration for the erection of a new finishing mill at its plant of 3-stand, 28-in. type. The equipment will be electrically-operated. The expansion will be carried out in connection with a 1926 betterment program. The company constructed a one-story addition to its mill a few months ago, providing considerable increase in output.

The Colonial Steel Company, Pittsburgh, Pa., has plans under consideration for extensions and improvements in its plant at Colona, Pa. The project will consist of one or more buildings, with the installation of annealing furnaces and kindred equipment for extensive increase in capacity in this department. It is understood that a considerable portion of the plant will be electrified. The entire project will cost in excess of $500,000, with machinery.

The Vanadium Corporation of Colorado, Electric Building, Grand Junction, Colo., has preliminary plans under way for the erection of a new addition to its mill at Rifle, Colo., consisting of a one-story unit, and the installation of additional machinery to develop extensive increase in capacity. The expansion is estimated to cost more than $200,000, with equipment. It is expected to proceed with the work at an early date.

The McKinney Steel Company, Cleveland, Ohio, will soon begin superstructure work on additions to its finishing mill division, consisting of a number of one-story structures, now slated to be completed by the close of the year. The work will include a new 10-in. and 12-in. merchant bar mill, as well as an addition to the semi-finishing department, with installation of a new billet mill for furnishing material for the new bar mills.

The Carpenter Steel Company, Reading, Pa., is said to have perfected plans for the rebuilding of the portion of its mills at North Reading, Pa., recently destroyed by fire with loss estimated at $150,000, including equipment. The reconstruction will cost approximately a like amount.

The Tennessee Coal, Iron & Railroad Company, Birmingham, Ala., is perfecting details for a proposed expansion program at its plant at Fairfield, Ala., and will begin work on the initial structures at an early date. The entire project will cost close to $10,000,000, and will include two new blast furnaces, each designed for a capacity of about 600 tons per day; four additional open-hearth furnaces, each with rated output of 140 tons; installation of new equipment in the present blooming mill and continuous mill, comprising heating furnaces, ingot strippers and auxiliary equipment; and additional battery of 77 coke ovens, each of 16-ton capacity. It is also purposed to construct a new electric generating plant at the mill with capacity of 50,000 kw. utilizing the gas from the new blast furnaces, with new boilers and accessory apparatus. George G. Crawford is president.

The Universal Steel Company, Bridgeville, Pa., has work under way on improvements in its two electric furnaces, each of 6-ton type, and will fully modernize the structures. A new 3-ton electric furnace will also be installed, with auxiliary apparatus. An expansion program for 1926, now being arranged, will include the installation of new mills for considerable advance in capacity, consisting of a reversing roughing mill, as well as a 32-in. and 44-in. sheet mill. It is expected to make extensions in other divisions of the works for greater grinding capacity, storage, shipping and miscellaneous operating service.

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